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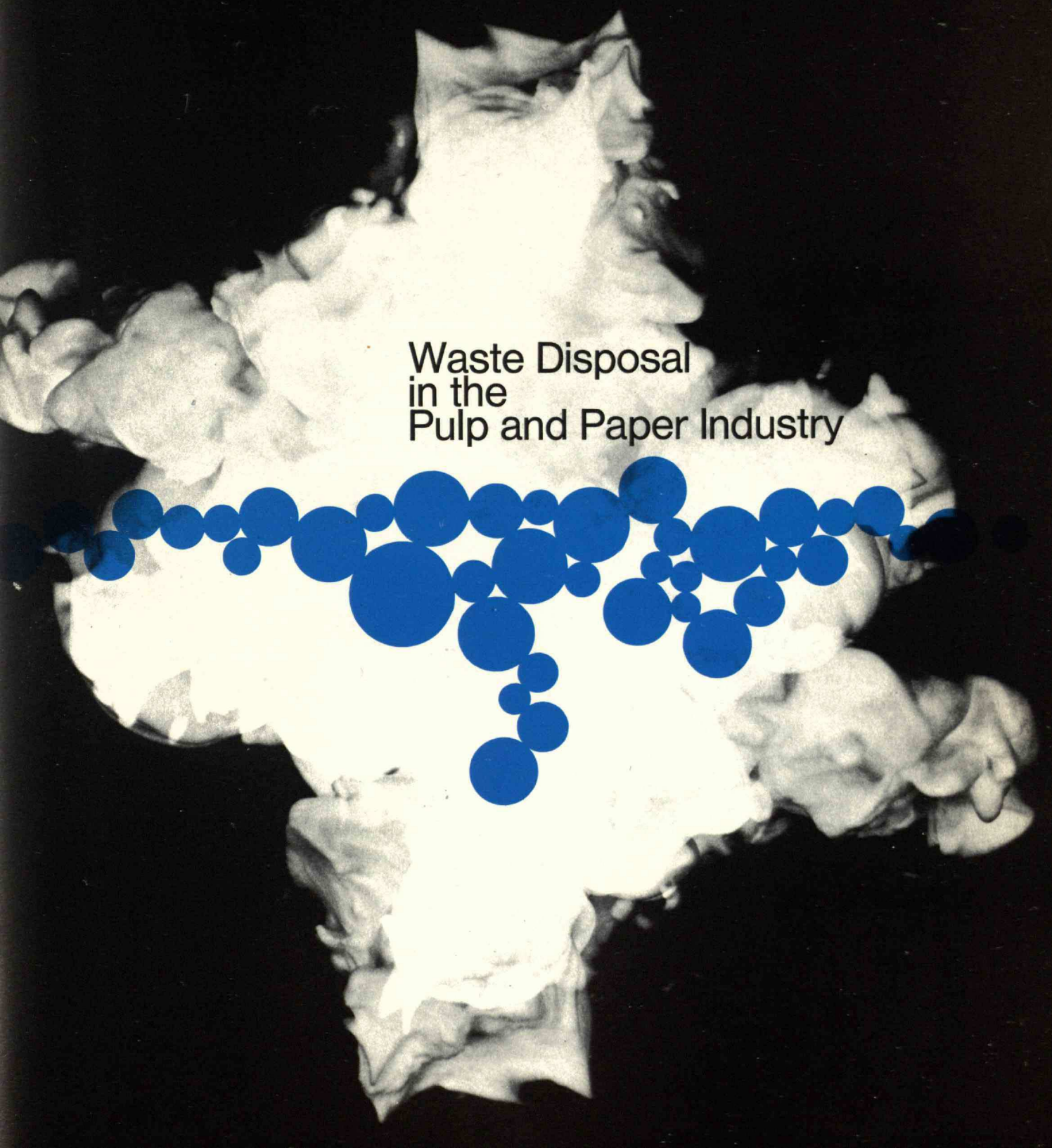
Henry I. Bolker on Pulp and Paper Effluent

Don K. Price on Science Policy
David J. Rose on Environmental Laboratories
William E. Small on Agricultural Wastes
David Buhl and Lewis E. Snyder on Astrochemistry

Technology Review



Waste Disposal in the Pulp and Paper Industry

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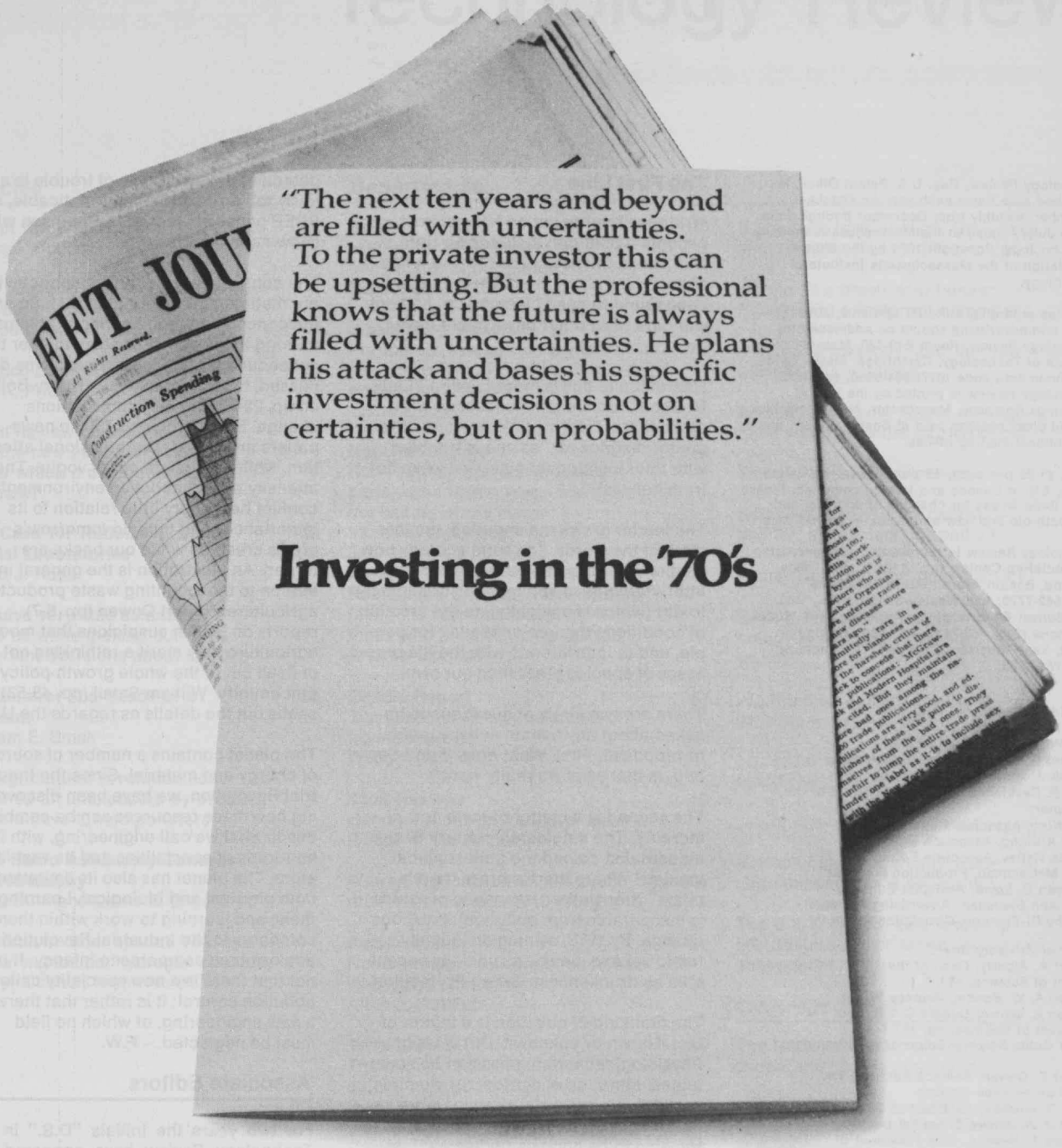

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The First Line

Writings about pollution have almost become a pollution in their own right. One opens the newspaper to find half a square yard about the latest things to have been found to need cleaning up, and one wonders what other news might have been fit to print.

How much of this is mere fashion? Lady Macbeth, too, became obsessed with cleanliness. "Not so sick, my lord," the doctor diagnosed, "as she is troubled with thick-coming fancies, that keep her from her rest."

The louder grows the shouting, the less distinct the words. The term *ecology* now means, *inter alia*, the gathering up of city litter. *Pollution* is applied indiscriminately to dirt (which is unsightly), to the creation of conditions that are unhealthy for people, and to interference with the life processes of species other than our own.

There are two kinds of questions to be asked about any human activity, actual or proposed. First, What does it do? Second, Is that what we really want?

The second is a matter of taste and morality. The nineteenth-century British industrialist coined the philosophical maxim, "Where there's brass there's muck" (translation: economic progress is inseparable from pollution). Fashions change. By 1975, owning an illegally fumid vehicle may be as socially acceptable as drunkenness during Prohibition

The first kind of question is a matter of fact–known or unknown. Dirt is visible. Physiological harmfulness can be ascertained, although at a price; for example, some of our industrial chemicals are carcinogenic, but a great deal of work remains to be done on finding out just which (as was shown in the report on p. 64 of this magazine last month). As regards truly ecological effects, we are surrounded by unknowns on all sides. The magnitude of the scientific task that faces us in attempting to unravel the consequences of our technology (so that real choices can be made) becomes clear when we read David Rose's proposal for a chain of National Environmental Laboratories (pp. 38-47). On the global scale, even detecting the symptoms of trouble is a fairly tall order–although practicable, as SCEP panellist George D. Robinson will show next month.

The consequences of particular activities are matters of researchable fact. So are the concomitant engineering problems of altering those activities so as to alter the consequences–the kind of problems discussed, for one industry, by Henry Bolker on pp. 22-29. But here too, fashions change. Some problems fill the newspapers and attract Congressional attention, while others are out of vogue. The intensity of fuss about an environmental conflict bears very little relation to its importance. And thus do tomorrow's crises creep up while our backs are turned. An illustration is the general inattention to the mounting waste products of agriculture. Robert Cowen (pp. 6-7) reports on British suspicions that modern agriculture may merit a rethinking not only of itself but of the whole growth policy of that country. William Small (pp. 48-53) spells out the details as regards the U.S.

The planet contains a number of sources of energy and material. Since the Industrial Revolution, we have been discovering how these resources can be combined: this is what we call engineering, with its hundreds of specialities and its vast literature. The planet has also its limitations, both physical and biological. Learning them, and learning to work within them, compares to the Industrial Revolution as adolescence compares to infancy. It is not that there is a new speciality called pollution control; it is rather that there is a new engineering, of which no field must be neglected. – F.W.

Associate Editors

For two years the initials "D.S." in *Technology Review* have appeared after bright, perceptive pieces about the Cambridge community from which this magazine issues. They stood for Deborah Shapley—a name now missing from *Technology Review's* masthead. Miss Shapley has been lured to Washington, D.C., by the American Association for the Advancement of Science, her place to be taken in Cambridge by Brenda Kelley and *her* place by Kathleen B. Sayre, Assistant Editor.

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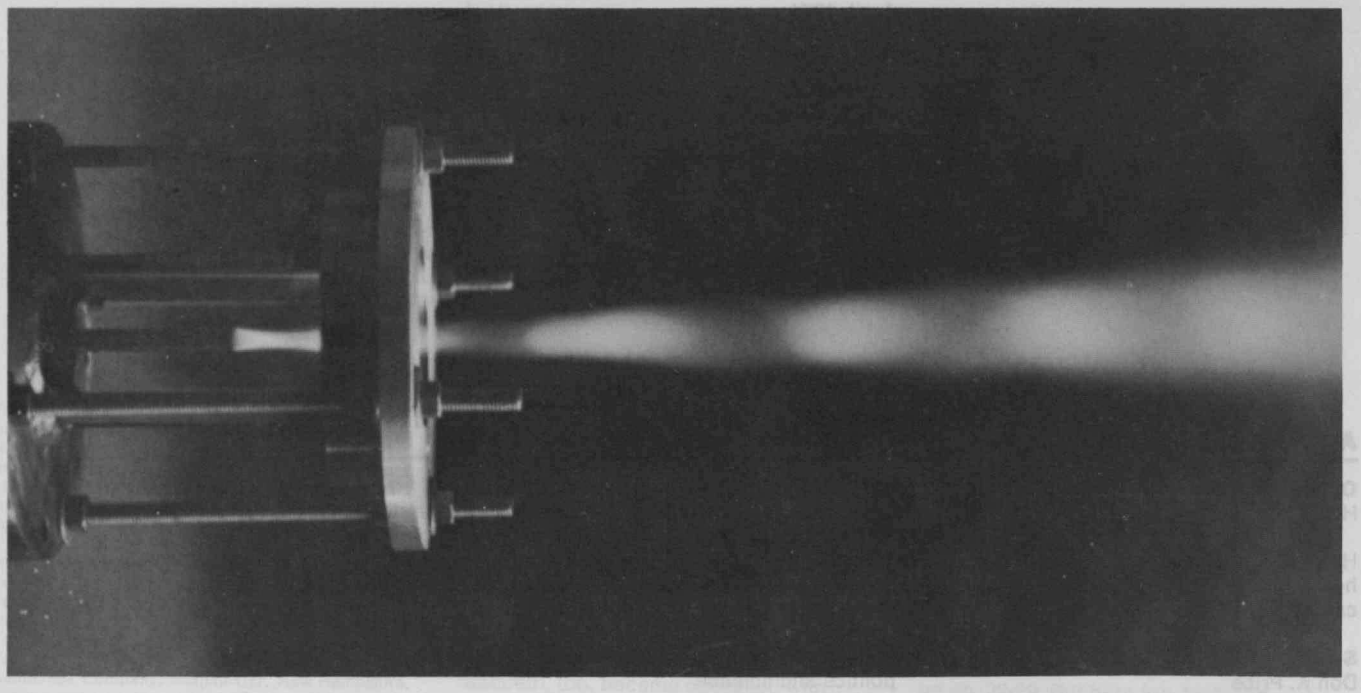

Variation of Flame Intensity with Ignitor Pilot Power and Stagnation Temperature in Mach 2 Stream

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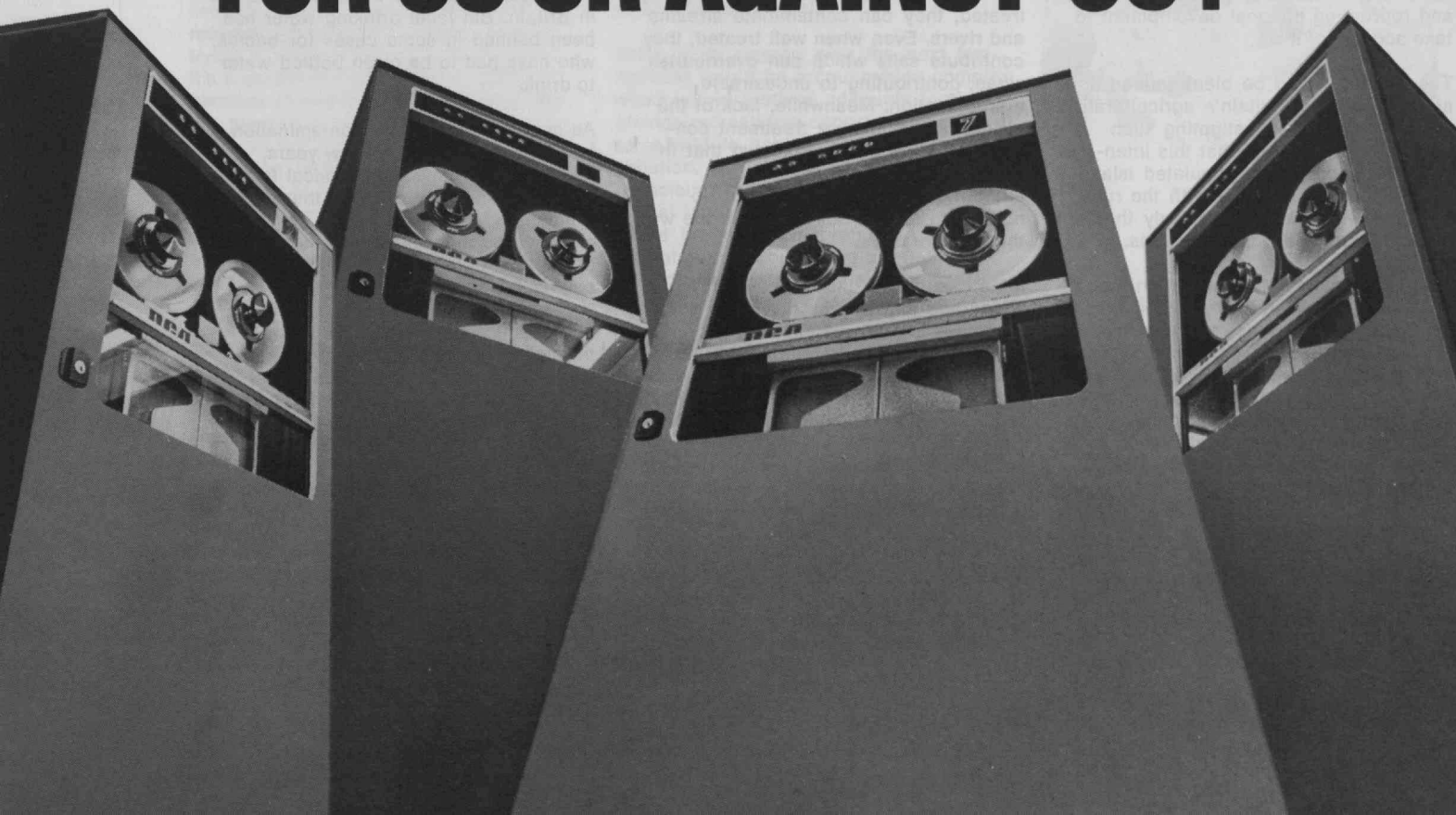


Agricultural pollution resulting from high-yield farming—discussed in detail on pages 48-53—is seen by some British experts as calling for radical changes in that country's total development strategy

Farm Pollution and a Nation's Future

Come spring, I have a mental picture of this magazine's editor trundling barrow loads of manure to a garden he's made into one of the most fertile plots I know. He should come do it in Britain. His example is sorely needed. Manure, once the great restorer of Britain's farmlands, has become a financial embarrassment to today's high-productivity farmer. What's worse, it's an increasingly important factor in the growing problem of agricultural pollution. (For the U.S. version of this problem, see William Small's article in this issue.) Farm pollution threatens to be a bigger environmental challenge by far than any of the mess cities and industries make.

Pollution watchdog Kenneth Mellanby has a vivid way of pointing up that challenge. However bad the problems, he notes, urban and industrial pollution are, in principle, solvable. But he thinks some of the worst aspects of agricultural pollution are beyond remedy *in principle* unless society is willing to accept some rather drastic changes in national growth. These include such unthinkables as expecting decreased rather than increasing yields from farms and reordering national development to take account of this.

The outlook would be bleak indeed if at least some of Britain's agriculturalists were not already investigating such heresy. It may well be that this intensively farmed, heavily populated island will point a way to cope with the rural pollution which will increasingly threaten all agriculturally advanced regions.

There's far more to this pollution than pesticides and weed killers. As head of the Nature Conservancy's Monks Wood Experimental Station, Dr. Mellanby has looked rather thoroughly into the way these chemicals can infiltrate the environment. He's been a leader in getting their use under rather tight control in Britain. He does not now think they present any unmanageable threat.

He's far more worried about things like the manure embarrassment. That's a symptom of the intense pressure on farmers for higher productivity. And that pressure provides the real driving force behind rural pollution.

In Britain, something like 12 million cattle, 7 million pigs, and 127 million poultry live indoors or in very restricted areas. Their droppings used to fertilize the fields where the cattle grazed or, collected from barns, were spread as a soil enrichment. Factory farmers often don't have the land on which to spread the manure. It can be uneconomic, indeed labor isn't always available, to move it around to fields that could use it. What's worse, the waste from factory farms is an evil smelling slurry, not the relatively inoffensive rotted barnyard manure of yesterday. Its use on land could be a public nuisance.

The resulting disposal problem has been bad enough to put some factory farmers out of business. Others spread the wastes on small bits of land, where high concentration poisons the soil and may find its way into rivers. Still others pay heavily to use the public sewage system or even install treatment plants of their own.

Looked at as sewage, the animal wastes are like city wastes. Untreated or partly treated, they can contaminate streams and rivers. Even when well treated, they contribute salts which can overnourish algae, contributing to undesirable eutrophication. Meanwhile, lack of the old-fashioned manure treatment contributes to the soil breakdown that in some areas is beginning to worry authorities. Chemical fertilizers do nothing to restore soil humus in the way that manure does.

It's a case where the forced draft to encourage productivity has been self-defeating. It is economic and productive to shift husbandry to factory farming. It is uneconomic to process and use the resulting manure. A subsidy to chemical fertilizer, which amounts to a negative subsidy on manure, exacerbates the problem. This is giving rise to a growing "sewage" outflow from the countryside that can contaminate rivers even before cities get a crack at them.

The Inescapable Nitrate Trap

Dr. Mellanby is trying to get the government to review its farm policies and reconstruct the system to make beneficial use of manure. It will be a challenge. But he says he's confident it can be done, and done in time to contain the serious pollution threat that is beginning to arise from this source. He's far less sanguine about another menace from the farms—nitrates.

Nitrates and phosphates are essential plant nutrients. Escaping into rivers and lakes they also nourish algae growth and the eutrophication that ruins many inland waters. Phosphates seem largely an urban problem. Those used on farms stay fairly well bound to the soil. The pollution seems to be coming from phosphate-containing detergents and other domestic and industrial chemicals. This problem can and probably will be handled at the source.

Nitrate pollution is something else again. It seems definitely to come primarily from farming. What's worse, it can poison people as well as drive eutrophication. Too high a concentration of nitrates in drinking water, or on vegetables, is especially dangerous for young animals and babies. It has caused deaths in some countries. None have been reported yet in Britain. But local drinking water has been banned in some cases for babies, who have had to be given bottled water to drink.

As concern with nitrate contamination has grown over the past few years, fingers have pointed at chemical fertilizers. Dr. Mellanby explains that the problem is far too complex to single out any one culprit. Indeed, the polluter is the total agricultural system with its emphasis on maximum yields.

The chemicals do contribute to the problem. In extreme cases, runoff can dangerously contaminate local water. Yet if farmers were somehow to find the means to switch back completely to manure, Dr. Mellanby says we'd still have the nitrate problem. It's inherent in high-yield farming. This demands a high level of nutrient salts however they are supplied. A proportion of them will leach into the rivers. Whatever the fertilizer used, the higher the state of cultivation, the greater the nitrate loss. There's no way to break out of this trap, Dr. Mellanby says, other than to back off

There is no doubt that "factory farming" is an effective way to increase agricultural productivity. But it also results in concentrated agricultural waste, and the resulting disposal problems turn out to be an unexpectedly serious byproduct. (Photo: U.S. Department of Agriculture)

from maximum-yield farming. That's asking for nothing short of a change in national philosophies of growth.

G. P. Wibberley, Professor of Countryside Planning in the University of London, says Dr. Mellanby's right. He says he and many other agriculturists recognize this now. But consider the pressures.

Britain looks forward, in the year 2000, to having lost an additional million acres of farmland to urbanization. In the same period, it expects to gain an extra 10 million people to feed. It will always have to import food. But with world needs mounting, it must plan for as much domestic production as possible. Factory farming, chemicals, heavy machinery, removal of wildlife-supporting hedgerows and all the other features of the new farming have seemed the golden route to such achievement. Already they have boosted yields three or four times. Now, unexpectedly, this route is running into fundamental troubles.

"We have been thinking we have done good," Dr. Wibberley observed after listening to Dr. Mellanby's analysis recently. "It may be," he said, "that in trying to do good we have done harm." It's a perplexing situation, he added, because at one and the same time "we are pressed to get maximum yields, to preserve the richness of wildlife habitat, to release an extra million acres of good farm land, to prepare to feed an extra 10 million people, to maintain a peaceful countryside environment for solitude seekers, to cut pollution, and so on. We can't sign a blank check for the ecologists."

Re-Plan the Nation's Development?

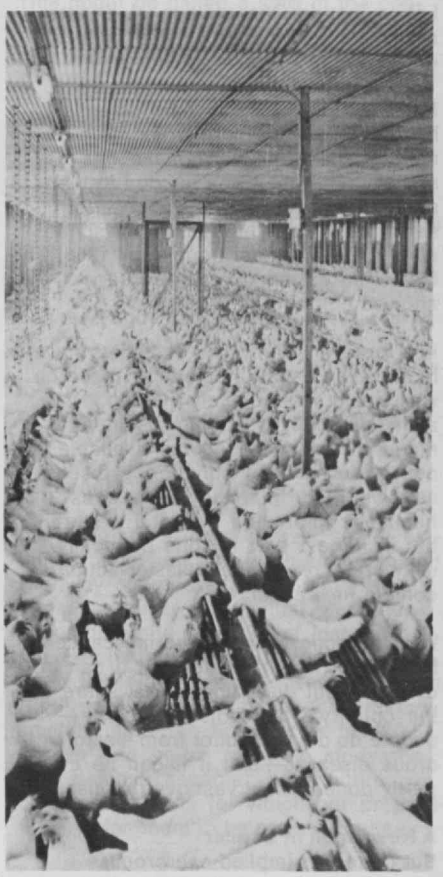
If society is willing to readjust these multiple pressures, Dr. Wibberley thinks that, at least in Britain, the rural pollution menace can be averted. A pleasant countryside can probably be maintained too. Studies in his department suggest that those extra 10 million people can be fed by the century's end with planned decreases in farm yields if all other national development is replanned with this in mind. This means town and city expansion can't go on taking farmland. It means industry has to adjust its development to reduce pressure on farmland too. It means rethinking long range water-supply schemes where reservoirs would detract from farming.

Since food production is so basic, all of this calls for a new national awareness. People generally take it for granted that the food will be there. This is just another way of saying that they tacitly expect maximum-yield farming to go on developing as it has in the past, accommodating to losses of farmland by putting on production pressure. Now industrialists, town planners, indeed everyone will have to accommodate themselves to lower-production farming if countryside catastrophe is to be averted. It's virtually asking for the adoption of a new ethic.

Part of that ethic has to be willingness on the part of the total community to underwrite the cost of switching agricultural development in this fundamental way. Tax adjustments, subsidies, even higher food prices will be needed to help individual farmers. Some of the required practices could be quite uneconomic under the present system. The transition could involve hardship.

What could emerge over the next few decades would be a countryside complex which would produce adequate food, provide recreational opportunities and some wildlife habitat, and minimize pollution. It would be a countryside consciously integrated with the city into a total landscape for the nation. There would be many compromises. Environmental purists would have to rethink their desires as radically as farmers. It sounds like a demand for utopian cooperation and mutual understanding. Yet there seems to be no real alternative.

Even though it sounds extreme, Dr. Mellanby probably is right when he calls agricultural pollution inherently insolvable under the accepted philosophy of maximum yields. No one gave him an argument about it when he made the case at Wye (agricultural) College. And given the nature of the nitrate menace, he's probably right when he says that agricultural pollution will be one of the biggest environmental questions of the future. Is it really utopian then to expect the rethinking that this challenge demands?



Robert C. Cowen, who writes regularly in this space in Technology Review, *is Science Editor of the* Christian Science Monitor *now stationed in London.*

Two contrasting areas of federal research funding: cancer and earthquakes. To one goes a great deal of money while other health needs are neglected; to the other, too little, too late

A Tale of Two Disaster Areas

Let us ponder the politics of disaster, as they are practiced in this political disaster area called Washington.

For a couple of light years scientists have been saying there would be a disastrous California earthquake one day and a little money was needed to learn to predict earth movements and erect safer buildings. They said it in spades after the Alaska earthquake of 1965. The California earthquake of February 9 showed no one was listening.

For three or four years scientists have been saying that biomedical research was being inadequately funded. Here, someone finally is listening. Some new money is going to become available, but not in the name of conquering disease as a whole, or improving Americans' health, or improving our total welfare, but in largest part for one politically sexy brand of medical disaster-action: conquering cancer.

What's wrong with conquering cancer? Nothing, if it can be done, if it can be done without distorting a vast share of the country's biomedical research—people do die and suffer from less glamorous diseases—and if it can be even partly done without vast overpromise.

A New Moon in Cancer

But there was implied overpromise when, in his January 22 State of the Union message, President Nixon dropped this surprise: "I will also ask appropriation of an extra $100 million to find a cure for cancer, and I will ask later for whatever funds can effectively be used. The time has come when the same kind of concentrated effort that split the atom and took man to the moon should be turned toward conquering this dread disease. Let us make a total national commitment to achieve this goal."

"I hope people understand just one thing," the National Cancer Institute's Dr. Frank Rauscher said later. "We can do this job. We're sure of that. But if people think we can do it by 1976 or 1980, it's really very erroneous. If we had an anti-breast cancer vaccine today and we vaccinated many thousands of female babies, we'd have to wait many years to know the result.

"It would be a shorter wait if we developed a vaccine against childhood leukemia. But even then we would have to inoculate many hundreds of thousands and wait six years."

In other words, the conquest of cancer is not exactly around the corner. We possess neither the chart nor the spaceship for this particular lunar voyage, and we do not know when we will have them.

If cancer were conquered tomorrow, moreover, the disgraceful infant and maternal mortality in America's depressed states and ghettos would still place us well down the list of western nations in these sensitive health indices. If cancer were conquered, the American children and adults who get inferior medical care would still be getting poor care, or none. True, on February 18 the President delivered a fuller health message, with some promise of actions to pay for and provide more health care for the poor and depressed. "Some" promise is all that can be said. There was no total national commitment to total care.

Why, then, to cancer? Politics, dear reader, politics, is part of the story.

In the past few years the top figures of the American Cancer Society—persons who believe with religious fervor that conquering this disease is the *sine qua non* of mankind—have been disgusted with the lean sums available for medical research and training. Some persons in the health field had hoped a broad united front could be formed by many health organizations to fight for more money—to combat disease across the board. But others argued, very possibly correctly, that: "The public won't buy a 'health' crusade. It will buy a fight against a nice simple cause it can understand—cancer."

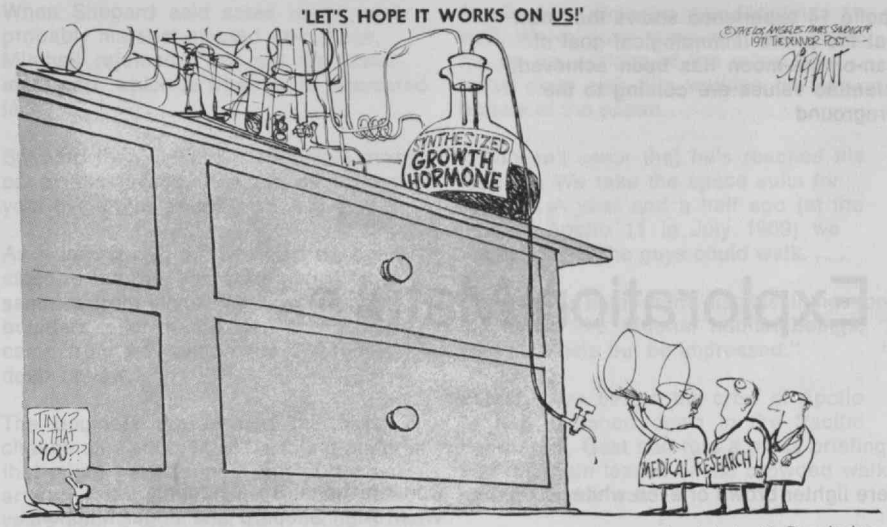
Also, many researchers and biologists pointed out, research into the nature of the cell and the gene had virtually become one with research into cancer virology and immunology. A cancer crusade, it was argued, would give a huge boost to basic biology, with possible understanding of many diseases.

Mrs. Mary Lasker, philanthropist, provided bankroll and zest. Big names among cancer doctors—Sidney Farber of Boston, Lee Clark of Houston—moved on the Congress. Their friend, Senator Ralph W. Yarborough, Texas Democrat, chairman of the Labor and Public Welfare Committee and its Health Subcommittee, marshaled a drive of his colleagues to name a 26-member citizens' and scientists' National Panel of Consultants on the Conquest of Cancer. Last December, hurrying because Yarborough had been beaten for reelection, the panel proposed a crusade that would cost $800 million to $1 billion a year "by 1976." It would be led by a new government agency: a National Cancer Authority.

Yarborough, at his health subcommittee's final session, allowed that he wouldn't be around for the '71 session. "I'd consider it an honor to introduce such legislation next year," volunteered Massachusetts' Senator Edward M. Kennedy, who has suffered from a broken back and some broken hopes and is eagerly riding health as a vehicle for return to popularity and power.

Kennedy is still a Kennedy, despite any setbacks; one can accuse him of lacking neither vigor nor conviction. He wasted no time this year in introducing a cancer authority bill—to spend $200 million in fiscal 1972, $400 million by 1973 and $600 million by 1974, "the level we need." He also won chairmanship of Yarborough's old health subcommittee, in this Year of the Patient an even better platform for pushing health causes. Among his new Senate cancer sponsors: old health crusader Hubert Humphrey.

It looked as though too many Democrats would be getting the credit. Three certified Republicans, all major contributors, all members of the Yarborough panel, as well as American Cancer Society-Sloan-Kettering Cancer Institute brass, moved. Elmer Bobst, a wealthy drug maker who is often called President Nixon's "honorary father"—the Bobsts and the Nixons spend Christmases together—saw the President. Benno C. Schmidt, Yarborough panel chairman, managing partner of J. H. Whitney & Co., saw budget director George Shultz. Banker Laurance Rockefeller helped. Mr. Nixon declared himself in.



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Washington immediately added a new fight to the cancer fight: who would get to spend the money? The National Institutes of Health already has the National Cancer Institute (precrusade budget: $227 million): its biggest unit. Even though most of the new money would probably be allocated by the Cancer Institute, N.I.H. doctors generally argued for an N.I.H.-wide attack; they did not want to "fragment" disease.

Some more aggressive Cancer Institute doctors wanted more: special contracting authority, as a kind of super-institute within N.I.H. They call ordinary N.I.H. procedures "too cumbersome and too slow," with too many layers of officials at too many desks who have to ponderously approve "every little thing."

Some scientists claimed that the Cancer Institute "has never had a coordinated national plan against cancer and lacks the people to define one." "There are smart people there," said Harvard biologist J. D. Watson—who sees the cancer answers coming from innovative basic biology—"but they aren't $100 million smart." Ergo, a separate Cancer Authority is a must.

Dr. Edward David, the President's science adviser, would have preferred an added $100 million for all basic science, rather than a cancer crusade. He lost that one. But he scored with the President on the separate agency question. There will be none, he announced. "We do not believe in an A.E.C. or N.A.S.A. for cancer."

Kennedy still wants a new agency, and "a specific national program—a 'moon shot' approach." The President in his health message attempted a compromise: a new "Cancer Conquest Program" in the office of Dr. Robert Marston, N.I.H. director, but with its own director, named by H.E.W. Secretary Elliott Richardson. The fight has not yet ended.

What will the public expect of the cancer fighters? Ultimately, cures.

"If the money doesn't produce any payoff," one Washington scientist said, "I dread the day five years from now when some congressional committee will be asking, 'Why was it wasted?' "

Quake Prediction: A Lost Chance

Now, about earthquakes.

Until 1965, federal anti-earthquake activity was slight. "The Alaska earthquake shook us up," Dr. William T. Pecora, director of the U.S. Geological Survey, admits. U.S.G.S. opened its first-rate National Center for Earthquake Research at Menlo Park, Calif. The White House Office of Science and Technology named a 13-member panel headed by Dr. Frank Press of M.I.T. to look at the state of research.

The Press panel was ready by September 1965 with recommendations. Expand research funding—then, some $5 million yearly—to $13, then $19, then a regular $26 million. Sow clusters of quake detectors throughout California and Alaska: watching them over the years could lay a basis for prediction. Begin an aggressive program of construction engineering, because "no" municipal building codes were adequate.

The main responses were an increase in research funding from $5 to $7.3 million by 1967, and a new study by a federal interagency group headed by Pecora. In December 1968 it largely agreed with the Press recommendations. Still, nothing happened.

O.S.T. then named a Task Force on Earthquake Hazard Reduction, chaired by Karl V. Steinbrugge of the Pacific Fire Rating Bureau. Last August it more or less repeated Press-Pecora, though in much more general terms and without budget estimates, and this time greatly emphasizing construction studies over prediction.

By and large, the recommendations of none of these studies have been carried out. Federal quake spending has crept up to just $8 million a year. As a result of failing to spend an extra $19 million a year since 1965, Pecora believes, the country may have lost a chance to achieve usefully accurate prediction as early as 1975. "Damage from earthquakes can run into the billions," he says, "and we're talking here about a few millions." "We may have to wait for damage in California in the billions," Press thinks, before we see quake research given higher priority.

For fiscal 1972, by the new Nixon budget, the Geological Survey would get an added $200,000. The National Science Foundation would get $3 million for quake engineering, up from $2 million this year and an average $1 million since 1967.

This might be called a start in the construction area at last. But very little, very late, in the view of most of those who worry about the uncertain earth.

New Buildings, Old Codes

On January 29, just on the eve of the February 9 disaster, structural engineer Steinbrugge warned in a National Oceanic and Atmospheric Administration report that in the next "great earthquake," some high-rise buildings in San Francisco or Los Angeles may collapse because code requirements have not kept up with building practice; that the likelihood of building collapse is increasing because of the increasing mismatch of old codes and new means of construction; and that even stairs in some tall buildings may collapse, marooning occupants to face terror and fire.

On February 9, notes Press, "A lot of things happened that were unanticipated. Highway overpasses and bridges fell." These were structures that were supposed to stand a quake of just 6.5 on the Richter scale, no big deal among earth tremors. "Gas lines were disrupted. All this after a quake maybe 80 times smaller than San Francisco's in 1900. People had better begin to study the civil defense aspects" of a future catastrophe—one for which our preparations so far seem to be a catastrophe.

Victor Cohn, whose report appears regularly in this space, directs the science reporting staff of the Washington Post.

National Report
Victor McElheny

Apollo 14 experience shows that, now that the prime technological goal of man-on-the-moon has been achieved, scientific values are coming to the foreground

Apollo 14: Lunar Exploration Matures

On Friday, February 12, only three days after the return of Apollo 14 from a very productive scientific exploration of the most varied lunar terrain yet visited, scientists were able to announce a finding that quickened their hopes that samples of rock analogous to the lighter-density continents on Earth had been collected.

The finding was that two rocks brought back in a large bag in the Apollo 14 cabin, when placed in a gamma-ray counter, had revealed a ten-fold higher content of the elements potassium, uranium and thorium than is found in the lava-like basalts of the lunar "seas" visited on Apollos 11 and 12. The readings from the pair of Apollo 14 rocks, which may or may not prove to be a general characteristic of the site (results of the preliminary examination will be announced in April), were about the same as from the dark portions of an exotic, conglomerate rock found at the Apollo 12 site, the famous 4.5-billion-year-old rock 12013.

Findings from that sample, and from exotic dust specks apparently cast out of nearby highlands at both the Apollo 11 and 12 sites, feed scientists' speculations that the upland areas of the moon may be a lighter-density crust, formed early in the moon's history, punctured by huge meteorites forming the basins of the great "seas," which later filled with lava formed by radioactive heating in perhaps the upper 100 miles of the lunar interior.

The high content of potassium, uranium, and thorium also fed other hopes. One of them is that a gamma-ray counter, to be flown in an "orbital science" package in the command and service module of Apollo 15, will be sensitive enough to help with surveying the chemical content of a broad swath of the lunar surface. Another is that it might be a bit easier to get good, unambiguous dates for the rocks collected among the hills north of the lunar feature called Fra Mauro.

It was clear to scientists in Houston that the crew of Apollo 14 had collected rock and soil samples unlike those brought back from the smooth sea surfaces. They included "football-sized" rocks, and many samples that were lighter brown or even white.

Another vital success was the establishment of a second long-lived scientific observatory on the moon, with a set of seismometers able to work along with those of Apollo 12 in locating the sites of meteorite impacts and "moonquakes" more precisely, and with a laser reflector able to work along with that of Apollo 11 in a long-haul study of the wobbles and swellings of the moon and the earth, by timing the round trips of photons of laser light to the nearest billionth of a second. The Apollo 14 reflector was "hit" from Texas the first night of trying.

Events initiated by the Apollo 14 itself exercised much of this equipment. The crash of the upper stage of the Apollo 14 rocket produced a seismic signal that lasted for some three hours (against four hours for a similar event last April). The crash of the upper stage of the Apollo 14 lunar module Antares, the evening of February 6, set off the seismometers of both Apollo 12 and 14. A "thumper," detonating firecracker-like charges, which was operated 13 times, sent signals to a string of geophones laid out for an active seismic experiment and revealed some kind of reflecting layer about 50 feet below. The plume of gas from the ascending Antares on the afternoon of February 6 was accelerated 10- to 100-fold, probably by the solar wind, and showed up as five spikes on an otherwise flat tracing from an ion detector at the Apollo 12 site. A like acceleration of particles from the Antares crash later was detected by a charged particle experiment at the Apollo 14 site.

But these successes were perhaps less important than the general sense of scientific maturity on Apollo 14, which was characterized by ease of communication between scientists on the ground and explorers on the moon, which in turn comes from an enhanced mutual respect between engineers and scientists in the space program. A kind of engineering fanaticism is necessary to make sure the sophisticated Apollo transportation system actually delivers explorers to the lunar surface. Scientific exploration is becoming the chief reason for continuing the adventure.

Conversational Rock Hunting

When Alan Shepard and Edgar Mitchell, the lunar landing crew of Apollo 14, were struggling with undulating terrain and a pressing schedule on the slope of Cone crater the morning of February 6, they could easily have lost sight of the scientific goals of their selenological traverse. But they did not.

The astronauts did dispute among themselves about how close they were to the crater rim and the big boulders that would have been thrown from the deepest level within. Shepard noted that the rim seemed 30 minutes away and that he and Mitchell had collected few "documented" samples yet.

Radioing to a third astronaut, Fred Haise, in the Mission Control center a quarter of a million miles away, Shepard noted: "Our positions are all in doubt, now, Fred-o. What we were looking at was a flank. . . . The top of it wasn't the rim of Cone. We've got a ways to go yet. . . . I'd say that the rim is at least 30 minutes away."

Haise, who would have been in Mitchell's place if Apollo 13 had not been robbed of a lunar landing by an explosion in space, could follow the two men's progress on the moon by looking at a television screen on his console, showing a map of the traverse route with a white pointer to the probable location of the astronauts. The map and the TV camera were in a room full of scientists who had planned the traverse. Through the TV, and by phone if necessary, the scientists could communicate to Haise. When they had a question, they could write it out in pencil on a white sheet of paper and slip it over the map. Haise would radio the comment up swiftly. By the radio hook-up, engineers on Earth could monitor the heart-rates of the astronauts and the rate at which they were using oxygen and cooling water in their multi-layered moon suits (which really were little spacecraft).

In the undulating terrain, the rim seemed to recede. Shepard said, "I don't think we'll have time to go up there." Mitchell replied, firmly, "Oh, let's give it a whirl. Gee whiz, we can't stop without looking into Cone crater."

When Shepard said some rocks were probably material ejected from Cone, Mitchell rejoined, "But not the lowermost part, which is what we're interested in."

Shepard then yielded, "O.K. We'll press on a little farther, Houston. And keep your eye on the time."

As it turned out, the two men were very close to the rim, and were able to take samples from white and brownish gray boulders taller than a man that obviously came from well within the 250-foot-deep hollow.

The boulders represented the best chance on Apollo 14 of sampling material that might have formed part of a crust around the embryonic moon 4.5 billion years ago, a crust that John Wood of the Smithsonian Astrophysical Observatory and others suggest contained much material like the anorthosite mineral found in the Adirondacks mountains. The crust would have been punctured by huge meteorites like the one that formed the basin of the Sea of Rains and sent shock fronts pushing debris out to regions like the hills of Fra Mauro. There, the ancient material would have been covered by later debris from craters like Eratosthenes and Copernicus, only to be dug up again by the meteorite which made the fresh crater Cone.

The close consultation between the astronauts on the moon and scientists back on Earth was reinforced by such means as a debriefing on the trip of more than four hours, immediately after it was over. The astronauts, who had radioed down many visual observations as well as the sample bags they were filling and the photo magazines they were using for "documentation," added many details about what they had seen.

At the end, Shepard thanked Haise for the counsel during the difficulties near the crater rim: "That was a good job of getting us sorted out up there when we got behind the time-line, and we appreciate that help."

Mitchell added, "There were so many things that we'd like to have done. . . . So many interesting things to look at here, and we didn't even have the chance to scratch the surface. We hope we've brought back something that you can sort out as time goes on."

Initiative and the Time-Table

Those comments of Mitchell's about the pressure of a tight schedule and a sense of scientific opportunities merely glimpsed struck a responsive chord in many scientists back on Earth.

One of them was Dr. Paul Gast, who has taken a leave of absence from Columbia University to serve as chief of planetary and earth sciences at the Manned Spacecraft Center in Houston.

In an interview, Gast commented that "the impressive thing that comes out of Apollo 14 is that the man functions so well. We've done more with man walking on the surface of the moon than we've done with him walking on the bottom of the ocean.

"It doesn't seem that he's reached his limit . . . We take the space suits for granted. A year and a half ago (at the time of Apollo 11 in July 1969) we didn't know if the guys could walk. . . .

"When you hear them discuss things on the moon like rational human beings, you can't help but be impressed."

Earlier, even before the crew of Apollo 14 had splashed down in the Pacific February 9, Gast had told a press briefing that the main lesson of the crowded walk to Cone crater was:

"Leave more leeway. Leave more time. Don't cram the timeline with so many stops. Let them decide how long it would take to reach objectives. In making plans for future missions, we must leave more time for men to make their own decisions. They need thinking time."

The men had functioned "extremely well" on the moon, Gast said. "Their eyes worked. Their brains worked. They were not seriously impeded by their spacesuits and the way they had to work. Every time we go to the moon, the adaptation of men to the lunar surface seems to grow. His ability as a field geologist should not be sold short."

At another press conference the following day, these views were run past the astronaut who selects among his colleagues for flights to the moon: Donald K. Slayton, director of flight crew operations at the Manned Spacecraft Center.

His first comment seemed to conflict with Gast's point of view: "I think we would rather have a rather stringent timeline. We recognize that we can't simulate either zero-G or one sixth-G in total in our training exercises, so we put some pad in there. But on the other hand, I think it would be very bad if we ended up with five hours on the moon surface and we only programmed two and a half hours' work. We'd much rather have it the other way around."

But in field geology it is different, Slayton acknowledged, especially on missions like Apollo 15 which will be using a Rover tractor to carry the astronauts from one site to another. "We'll be seeing things that may not necessarily be like we thought they were from the maps. . . . You like to pre-plan everything the best you can, based on what you know, but I think we've got flexibility there for the crew to do what they think is best on the scene."

Slayton also acknowledged that research has become the main reason for continuing to fly to the moon, and for making plans to have the crews of Apollo 15, 16, and 17 stay some 66 hours on the moon and do extensive photomapping and chemical composition surveys from orbit by the end of 1972.

"I think we have a fair amount of support for our programs at this point. . . . The big difference between now and two years ago is that we had a goal, which was to land on the moon. There was a significant goal that everybody could clearly understand. We'd been working on it for a total of about seven or eight years before we got there. . . . There was a certain amount of national challenge . . ."

But "the real purpose of going there was, in fact, to do science," Slayton said, "and that's what we're doing now. It's a little harder in that area to explain exactly what your return is."

The scientists, as they get a better idea of the sequence of events on the moon, testable by the remaining Apollo flights, grow more enthusiastic about the moon as a place to study the early history of the earth, now effaced. They look forward to the "little bit of everything" trip to the lunar canyon called Hadley on Apollo 15 (which also provides a mountain front, volcanic domes and a mare surface, all sampled in view of a television camera, aboard the rover tractor, that can be aimed and focused from earth without bothering the astronauts). They also are eager for an Apollo 16 visit to the highland terrain of Descartes and on Apollo 17 to a landing in the crater Copernicus.

After 1972, What?

Gast remarked in an interview that many people now skeptical about the adventure of exploring the moon "will find it hard to accept (in December 1972) that we have absolutely no plans to go back to the moon."

There are many ways of remedying this situation. Two Saturn V rockets, now in mothballs, could carry lunar modules equipped for a longer lunar stay in the late 1970's, either revisiting an interesting site or trying a new one, either one at a time or in a pair of landings. And the Russians and Americans might make a plan—perhaps geared to the 500th anniversary of the birth of Copernicus in 1975—for unmanned Russian exploration of a site with one of their Lunokhods, followed by a manned landing with American equipment.

Victor McElheny, who contributes regularly to Technology Review, *is Science Editor of the* Boston Globe.

European Report
Andrew Jamison

Their efforts to restore polluted lakes have brought Swedish scientists face to face with the issue of their role and its limits. Must scientists be content with supplying information, or will they become active proponents for schemes of correction and change?

Swedish Science: Saying What Should Be Done

When I visited Lake Hornborga in early September, it looked like an overgrown marsh. A few ducks were swimming in the little bit of water that was visible; but for miles around (the original lake covered an area of 30 square kilometers) there was an endless expanse of vegetation.

In the past, Lake Hornborga has been a kind of rare bird sanctuary. A great number and variety of birds would rest at Hornborga during the summer and fall, and ornithologists and bird enthusiasts from all over Scandinavia would come to observe the strange birds that ventured so far north (Hornborga is about 120 kilometers northeast of Gothenburg). But in recent years, as a result of a series of lowerings of the lake to use the fertile banks for farming, the number of visiting birds has dwindled. Now, with the lake almost nonexistent for most of the year, Hornborga is the object of a massive restoration project.

A few weeks later I went to Växjö, which lies about a third of the way up on the diagonal from Copenhagen to Stockholm. There I saw Lake Trummen, a polluted, reed-infested body of water, much smaller than Hornborga (only one square kilometer). Trummen had served until 1958 as the sewage recipient for the town, and the natural process of eutrophication, which had been rapidly accelerated by the pollution inflows, had not tapered off in the years since as was hoped. Rather, the rate of eutrophication has continued to increase so that now the sight-depth in most parts of the lake is less than a foot and the banks are beginning to move into the lake itself. But Trummen is now well along on a major restoration, and it is hoped that it will be usable (perhaps for swimming) by the mid-1970's.

It is the science of limnology that studies the interactions of plants and animals with their environment in lakes, i.e., lake ecology, and it is the practical use of limnology that is giving some hope for the future to Lakes Hornborga and Trummen in Sweden.

Hornborga has always been a special interest of Sven Björk, now Professor of Limnology at the University of Lund. Björk's doctoral thesis dealt with water reeds, and he used Hornborga as his area of reference. He became well aware of what was happening to the lake as a result of the five lowerings that had taken place within the last century and a half. Indeed, most of the small lakes in southern Sweden have been lowered at one time or another for agricultural purposes. Hornborga became a special case as ornithologists kept complaining about the lake's deterioration through the 1950's and 1960's; thus, when the Royal Swedish Environmental Protection Board was established in 1967, one of its first acts was to launch a study of what could be done about Hornborga. Professor Björk was asked to lead the investigation.

One of the first steps was to see if there was any way to cut the reeds. Professor Björk had worked with Danish reed-cutting machines in the Danube Delta in Romania (where the cut reeds are used as a source for cellulose) and he, with other scientists, talked with the engineers about modifying the machines to make them useful at Hornborga. They studied those parts of the lake that seemed easiest to restore and drew up extensive plans. Experiments on limited portions of the lake will continue until 1974, at which time a definite decision will be made whether or not to proceed.

The long-range plans call for the restoration of the northern half of the lake (about 10 square kilometers). Restoration of the rest, due to the composition of the sediment, the thickness of the reeds, or the minimal possibilities for adequate waterflow, has been shown to be unfeasible from an economic point of view. By the end of the 1970's, however, if current prognostications are accurate, the program of periodic cutting, bounding restored areas from nonrestored areas, and raising the water level should result in Hornborga once again being a bird sanctuary.

"It is a unique project," says Professor Björk, "and we haven't had any place to turn for advice or past experience. But this is the kind of experiment that we should be undertaking. It is very important for university scientists to get involved with practical work." Hornborga is a showpiece project for the Swedish government, and this has made it relatively easy to obtain money for the Hornborga research; it has also focused a great deal of welcome foreign attention on the restoration work. "It is absolutely essential, for the future of environmental work, to show that limnologists are able to do something," Björk says.

Precarious Economic Base

The work on Trummen has been much more precariously financed. In this case it was Professor Björk himself who—along with a number of other scientists—initiated the project. The government finds it a much more questionable undertaking. It is financed, in equal shares to a total of about $400,000, by the Environmental Protection Board and the town of Växjö. Rather than having the approval of the government, though, the Trummen project is questioned at all levels.

It began, in 1967, with a letter from several Lund scientists to the Växjö town council. The plans that evolved called for the pumping up of the top one meter of bottom sediment—where most of the chemical and organic nutrients are concentrated—the cutting of the reeds, and the transformation of the surrounding area into a park with the dried sediment serving as a fertile base. "We waited and waited for government support," recalls Ulf Lettevall, who headed the project until October when he left the Limnology Institute at Lund. "And finally, with no advance warning, they said they'd help us out."

Industrial assistance was no problem. Three different companies wanted to take part, and Lettevall and Björk found themselves in the position of choosing which one offered to do the job best. They chose the Skanska Cement Co., which has had a good deal of experience in pumping and dredging for other purposes. "One of the valuable things about the Trummen project is that we have such close cooperation with engineers," says Professor Björk. "It is necessary to begin to break down the wall that has existed between scientists and engineers."

According to current plans, the actual restoration work should be completed by the end of this year. Research will con-

The restoration of Sweden's Lake Hornborga: the reed-choked lake before the project began, the cutting operations, and the effects of cutting with water beginning to accumulate. Cutting will be continued and the water level gradually increased until, by the end of the 1970's, Hornborga once again becomes an important wildlife sanctuary. Meanwhile, the project has raised technical questions—and broad issues about the relationship of scientists to public projects in Sweden. (Photos: Sven Björk)

tinue for seven more years. "But," says Professor Björk, "our economic situation is unclear. The authorities are interested in results, and, after the practical work is finished, it will probably be much harder to get money." The financial insecurity has already been a major reason for the departure of Lettevall and one other senior scientist from the Limnology Institute; but Lettevall's new job, that of county environmental specialist for the area around Växjö, will allow him to continue to do practical work. "We have to use our expertise to make things better," he says. "We can't just do our research and wait for somebody else to put our results into effect."

The Changing Role of Science

Indeed, the restoration projects have been a part of a changing role for science in Sweden, particularly in the environmental area. It's difficult, of course, to say whether the restorations are a symptom or a cause of this change, but there can be no doubt that a change exists. "Ten years ago, the standard work of an ecologist consisted of going to the most remote part of the country and studying the natural ecosystem of the plants and animals," says Per Brinck, Professor of Animal Ecology at the University of Lund. "Now, I'd say that the vast majority of our work is practically oriented. We are now looking at man's interference with his environment and trying to figure out what to do about it."

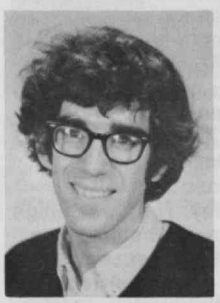
Most environmental scientists in Sweden shy away from the old basic-vs.-applied dichotomy. To them, science is science, and the more useful it is the better. The kind of contact with industry that goes on in the Trummen project is becoming rather common in Sweden. But still, things are shifting very slowly, and, in some institutes, the cry for more basic research remains dominant.

At the Limnology Institute at the University of Uppsala, the interest is more in data collecting. But one would be hard pressed to call it "basic" research. Most of the data involves the "great lakes" of Sweden—Vänern, Vättern, and Mälaren—and the first batch of information, showing large accumulations of chemical nutrients in Mälaren, was a big factor in launching the construction of a great number of chemical treatment plants along the lake's shores. "We need much more basic knowledge than we have now," says Wilhelm Rodhe, Uppsala's Professor of Limnology. "If we don't get it, all our future decisions will be meaningless." Says Thorsten Ahl, also from Uppsala and the leader of the great lakes investigations, "We have to supply the authorities with the best information we can provide."

The question that many environmental scientists in Sweden are asking, though, is whether such basic knowledge in and of itself is really the crucial concern. They call for synthesis of the data, for conclusions to be drawn, for recommendations to be given by scientists on the basis of their research. Such is the example of the lake restoration projects: the lakes were studied, their diseases diagnosed, and—the final step—a possible cure was prescribed. Many scientists at Uppsala feel that their colleagues at Lund were too rash in making the prognosis, that they did not have all the knowledge they needed before they prescribed the restoration work.

But, for many—particularly younger environmental scientists in Sweden—the restoration approach seems urgent. To them, the massive data-collecting approach seems too slow to be effective. The problems, they say, have to be solved today. "We are the ones with the knowledge," says one young limnologist working with the Uppsala group, "so why shouldn't we be the ones who say what should be done. There is a real reluctance here to do that. They would rather leave it to the authorities." For many scientists, the authorities seem only to be concerned with economic interests; they do not seem to be terribly concerned about the environment. "Science does not provide options," says Svante Oden, an environmentalist at the agricultural college in Uppsala. "Rather, it defines what has to be done if we are to preserve our environment."

In Sweden, as in many other nations, scientists seem to have two alternative approaches—one of subservience to the authorities and of merely supplying scientific information, and the other of proposing schemes of correction and change. The lake restoration projects are good examples of the latter possibility—of using science and scientists actually to affect environmental improvement. It is, however, too early to say whether such examples are more than unique, whether they will serve as a model for scientific contributions to the environmental policy in Sweden.



Andrew Jamison, who studied at Harvard, is a research associate at the Research Policy Program of the University of Lund, Sweden. He was Science Editor of the Harvard Crimson, *has contributed to* Science, *and is the author of* The Steam-Powered Automobile: An Answer to Air Pollution *(the University of Indiana Press, 1970).*

Seattle Report
William Osinski

Though its completion is problematical, the S.S.T. has already resulted in some important "spin-off" technology. New techniques for managing titanium, an exotic material that does not yield to conventional machining and joining methods, are an example.

Titanium and the S.S.T.

"We're about where we were with aluminum in 1925," says John Swihart, Boeing's Chief Engineer of Production for the S.S.T. Already, he says, the project has introduced titanium as a workable material.

These are modest results compared to the predictions of the melting of the polar ice cap, etc., advanced by some of the S.S.T.'s opponents. And while arguments about the S.S.T. may remain unresolved for a decade, a discussion with Swihart leaves one with the impression that wider applications of titanium will be feasible very shortly.

The pivotal decision to use titanium was based on the speed requirement of Mach 3. From there on it was a matter of economics. With a payload-to-gross-weight ratio of 8 per cent (compared with 10 to 15 per cent for subsonic aircraft), the operating costs had to be minimized. Moving the passengers faster appeared to be the best way. Later, it was found that hardly any of the auxiliary systems such as air conditioning and hydraulics functioned at Mach 3, so the speed was lowered to Mach 2.7.

The only three metals considered for the plane were aluminum, stainless steel, and titanium. The speed automatically ruled out aluminum, which loses its structural properties rapidly above Mach 2. Stainless steel proved to be simply too heavy. So titanium was chosen for such advantages as its high strength-to-weight ratio, corrosion resistance, fracture toughness, and ability to retain its properties for long periods at temperatures up to 500° F.

Inexpensive Tooling Devised

But the material also had some drawbacks. The original alloy, Ti-811, had high crack propagation rates in the presence of water vapor, so Ti-64 (6 per cent aluminum, 4 per cent vanadium) replaced it. Unlike other aircraft materials, titanium tends to crack during cold forming, so new methods of hot forming had to be developed. New drills and cutting tools had to be designed, since sufficient background experience in machining titanium to the close tolerances of the aircraft primary structure did not exist.

Forced to operate within the confining limits of the two-aircraft prototype budget, Boeing began looking for ways to save money on the exotic manufacturing techniques then available for titanium. These efforts resulted in some surprisingly simple tools which will be carried over to full-scale production—if it occurs—and which might find their way out of the aerospace industry.

A new mold was developed to retain the precise shapes to be fashioned from the titanium sheets. The mold is just a box filled with aluminum honeycomb core. A thick epoxy paste is spread over the top of the core. Once the epoxy hardens, a computer-controlled machine can mill the required contours into the mold, and an identical series of shaped parts can be stamped from it. Unlike other titanium molds, this one requires no environmental control and is completely portable.

The long-winded name of the vacuum creep forming tool belies its simplicity. It is a mound of firebrick-like blocks which are imbedded with heating coils and coated with a polymeric substance. A part is placed on the tool, covered with a vacuum bag, and heated to 1,400° F. Afterwards, the part won't creep.

Aerospace Developments

In addition, Boeing has come up with other new techniques in handling titanium that relate more specifically to their own product:

◇ A new alloy rivet, beta-3, and a new method of installation called "squeeze riveting." Though one wouldn't be able to guess from its name, this is a way of squeezing rather than hammering the rivet into place, thus reducing the stress concentrations at the rivet site.
◇ In-place welding for titanium hydraulic tubing and a camera that provides an immediate check of the weld.
◇ A draw-dye which operates at 1,900° F. and changes a cold-formed "lazy-S"-shaped piece of titanium into the Z-shape required for aircraft stringers.
◇ A plasma arc welding machine capable of producing a continuous weld of over 60 feet.
◇ Braze-bonding titanium sandwich structure by using sheets of aluminum foil placed on either side of titanium core as the brazing material. The cure cycle goes up to 1,290° F., then rapidly down.

Although drawings for the prototypes are finalized problems remain. For example, almost all the organic materials—external finishes, sealants, and adhesives—that are used on aluminum aircraft have proven unsuitable for the S.S.T., and new materials have had to be developed. The systems presently called for in these functions are passable but not entirely satisfactory.

To return to the wider implications of these advances in titanium, there are several factors that distinguish today's situation from the period when aluminum was introduced. The great increase in desirable properties achieved when changing from aluminum is matched by a whopping price differential in the materials. This in turn occasions the heavy presence of the federal dollar. However, the large scale of the S.S.T. project is already driving the price of titanium down. At $6 per pound, it is now cheaper than aluminum once was, and completion of the S.S.T. should reduce the price to $3 to $4 per pound. The man-hours required to work with titanium are still about 30 per cent greater than the working time for an equivalent weight of aluminum. But titanium can be machined almost as fast and is extremely easy to chem-mill, and new alloys are being developed at the university research level.

In their effort to be first in the supersonic

The picture on the opposite page shows the world's largest plasma arc welding machine, designed by Boeing's S.S.T. tool engineering group and built in the company's tooling shops. It has the capacity to weld 65-foot titanium assemblies in one continuous operation and was designed to attach stiffeners to 30-ft. S.S.T. wing skin sections; two wing sections—one being welded, one being prepared—can be accommodated at once. (Photo: Boeing Co.)

market, the French and English elected not to advance the state of the art and to build their Concorde primarily with existing aluminum technology. If a competitive situation does develop, however, the next version of the Concorde will probably be made of titanium.

But beyond the obvious aerospace applications, titanium now looks promising for use wherever low weight, high strength at elevated temperatures, and corrosion resistance are required. For instance titanium seems to be a natural material to use for such things as high-temperature processing equipment, parts of internal-combustion engines, home and industrial heating equipment, and marine vessels.

Has the S.S.T. indeed brought us to the threshold of an important advance in technology? And if so, how will we capitalize on the potential benefits? We may find out if the concept of "technical fallout" has really changed. Will this fallout still be called a myth by some and justified in terms of nonstick frypans by the rest? Or will this opportunity be seized to evaluate and utilize a technological advance for its broadest possible application to human improvement?

When Boeing elected titanium for the S.S.T., it took the gamble which Concorde refused. The result is a substantial advance in the state of the art of machining and handling this exotic material and the prospect of its widening use—in short, a new example of technical fallout

William Osinski prepared at Florida State University in engineering science—and is now making his own personal "conversion" to a writing career after several years' employment at the Boeing Co.

Of Men and Nations

To Rise Above the Commonplace

Pieces of the Action
Vannevar Bush
New York, William Morrow and Company, 1970, 366 pp., $8.95

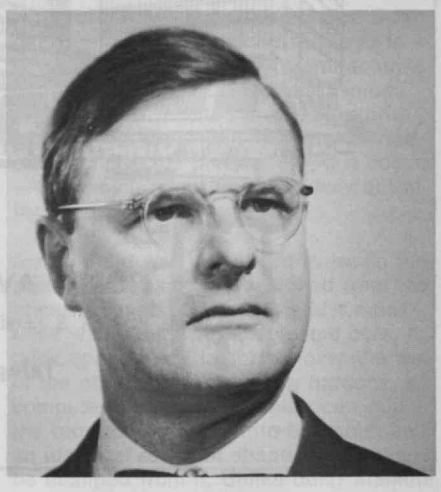
Reviewed by
Harvey Brooks
Dean of Engineering and Applied Physics
Harvard University

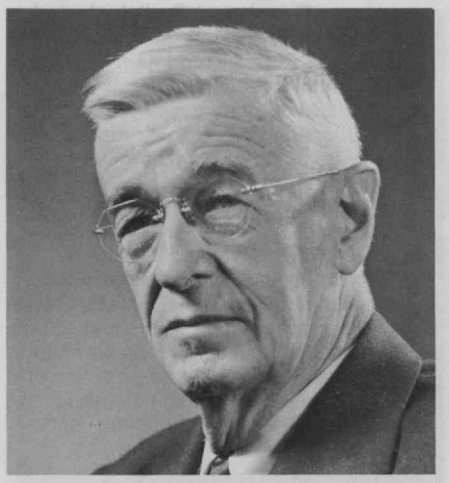
This fascinating book is appropriately titled. Few individuals in modern times have had more "pieces of the action" than Vannevar Bush. No single individual has had a greater influence over the shape of government-science relations in the past 25 years. Although he has held his share of the levers of power, the impact of his career upon the modern world greatly exceeds that which can be ascribed to the conventional criteria of power and influence. For his career exemplifies and symbolizes the unique leverage exercised by the application of modern science over the historical developments of the last 30 years.

This is not an autobiography in the traditional sense, but a thematically organized collection of reminiscences and occasionally acerbic running commentary on men and events, gleaned from the extraordinarily varied experience of the author. He does not hesitate to render judgment on any subject, or to reach back into ancient history as well as his own experience to support his assertions.

Simple, pithy, and pragmatic, there is little philosophical reflection, and few second thoughts in the book. And yet the simplicity is deceptive, almost artful, and there is more philosophy than meets the eye. In its absence of political and ethical theorizing, the book seems miles apart in style and outlook from much contemporary discussion of similar issues. And yet it has a good deal to say which is worth pondering. Above all, it is never dull, and from it emerges an engaging, forceful, puckish, and occasionally ruthless personality.

The book is not notable for false modesty, but it is generous with credit where credit is due, and from it comes a feeling for science and technology as a





Harvey Brooks, Dean of Engineering and Applied Science at Harvard (above), on M.I.T.'s Vannevar Bush (right): "Few individuals in modern times have had more 'pieces of the action.' "

collective enterprise, involving the cooperation of hundreds of individuals based on mutual respect. It is surprisingly free of the self-justification so often appearing in political and military memoirs.

Sketching many vignettes of personal relations among the wartime leaders—showing how things get done behind the scenes in Washington—Dr. Bush emerges from this account as a superb politician, finely attuned to the nuances of power. Though enjoying great formal power as head of O.S.R.D. he never neglected to keep his political fences mended. He skillfully used his direct access to F.D.R. to move mountains, but in such a way that it was seldom necessary to move outside of channels, despite his nominal power to do so. On page 38, for example, he describes an encounter with the Bureau of the Budget and the General Accounting Office which will bring grins of satisfaction to modern science advisers:

They accused me of being in a plot to fatten up the universities at government expense. But by then there was not much they could do about it. I just told the Appropriations Committee of the House what I was doing and how I was doing it. They seemed to think it was all right, so that was that. . . . After all, not even the Budget gets gay with that committee."

Or, again, listen to the following incident as recounted by Bush with obvious gusto:

My bird dogs reported that the President was about to appoint a Committee on Medical Research made up of some of the prime movers in the American Medical Association. Like many of my friends, I had a deep-seated distrust of that organization, so the next morning I breakfasted with Harry Hopkins in the Lincoln Room at the White House. I told him that the Great White Father was about to put his foot in it, and when he asked how, I said he was about to appoint a Committee on Medical Research, that three of the men he was to appoint were under criminal indictment in the District of Columbia, and that the columnists were going to have a field day. . . . I do not think anyone knew just who put the monkey wrench in the gearbox, but I understand a prominent official of the A.M.A., known to be loquacious at times, was so sure the plan was approved that he announced the great step forward that evening in Chicago. And I am sure my hustle to keep my chief from a misstep helped in our later relations.

These two passages not only illustrate Dr. Bush's political and literary style, but they also suggest that things have not changed much in Washington in 30 years.

A Record of Accomplishment

Of course this style of operation works for long only if it is backed up by a record of accomplishment, and Dr. Bush is careful to show that his organization did indeed produce superb results, and confounded most of the critics and detractors of O.S.R.D. He is quite frank about his methods and the reasons for them, as the following sample shows:

There were those who protested that the action of setting up N.D.R.C. was an end run, a grab by which a small company of scientists and engineers, acting outside established channels, got hold of the authority and money for the program of developing new weapons. That, in fact, is exactly what it was. Moreover, it was the only way in which a broad program could be launched rapidly and on an adequate scale.

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Dr. Bush does not pursue the broader political and social implications of this statement, nor analyze its possible connection with present public distrust of the scientific and academic community. If such a "grab" could be effected successfully in a good cause, could it not also be carried out in a "bad" cause, and how are the scientists and engineers involved to be held accountable to the larger society in such circumstances?

Dr. Bush's book is full of comments and observations that invite quotation. Few of the burning issues of today fail to get at least passing attention, but almost all of the comments are infused with an optimism and a sense of the possibilities of human accomplishment which I find refreshing, though completely out of tune with the modern temper.

Hiroshima: Few Second Thoughts

Unlike Oppenheimer and even Conant, Dr. Bush has few second thoughts about the release of nuclear energy. He had no illusions that, once the full power of science were really applied to warfare—and this seemed to him inevitable—humanity would be presented with two alternatives. "Either it could refrain, formally or informally, from use of weapons of mass destruction . . . or it could thrust itself back into the dark ages." Bush believes that only a dramatic and unequivocal demonstration of the power of modern weaponry could have convinced the world's political leaders to refrain, as he believes they have for the past 20 years. Thus, in his words, "if for no other reason I would justify the use of the bomb at Hiroshima and Nagasaki because it was the only way in which the dilemma could be presented with adequate impact on world consciousness." To many today this seems a cruel and callous judgment, but—perhaps as in the "grab" of the scientists for power in N.D.R.C.—only time will tell whether Bush is right or wrong. If weapons of mass destruction are in fact never used, then another generation may come to judge the Hiroshima tragedy less harshly than does our younger generation today.

Dr. Bush is in close agreement with C. P. Snow in his criticism of the Churchill-Cherwell relationship of scientific advising. Cherwell, he says, "felt he was bound to give Churchill his personal judgment on all such matters." In contrast, says Dr. Bush, "I regarded myself as a link between the President and American science and technology, and not as an oracle or an expert on all matters scientific. I know F.D.R. recognized this, although I never explained it to him. He asked a question, and he got an answer . . . and then I scurried around to make sure I had made sense." Regrettably, Dr. Bush does not really tell us how the difference between the British and American styles worked out operationally. How did he explain himself to F.D.R. when he found out, after checking with his colleagues, that he had been dead wrong on a piece of advice, as surely he must have been more than once?

Analyzing with some care his view of the proper spheres for military and technical judgments, Dr. Bush believes that the military should always have the last say on military matters. But "the planning, development, and procurement of systems of weapons" is not a purely military function, and therefore "the final decision should not be made by a single individual with unlimited authority. Yet it should be made within the military structure and should not be imposed from above by the civilian authority. What the civilian authority, the President, should do is to insist that what is done be done well," which "involves . . . deep study and planning, the opportunity for dissenting opinions to be fully expressed, the bringing to bear of diverse disciplines, financial, economic, scientific, engineering, management." Of course, the final program must have political sanction but, according to Dr. Bush, it should be subject to political approval only after it has had the "approval, after study, by a highly competent professional group, not made up of those who constructed the plan, nor those who will carry it into effect, but by a predominantly military group with some outstanding civilian membership and full civilian professional advice, and above all, a group that is genuinely independent." This last suggestion is definitely a novel one, and, in my opinion, long overdue for implementation.

Even military strategy must be planned with strong technical input:

At the planning table there should be at least one man who understands weapons, those of the present and of the probable future, in all their aspects, as completely as the conductor of a symphony orchestra understands music, in its traditions and current trends. The man should be a military officer. But he should be there, and it is up to the military men of the country to see that he is.

Dr. Bush attributes at least a part of our failure in Vietnam to lack of independent input to planning. He counts himself among those "who think we got ourselves into a mess in Vietnam largely because Kennedy and Johnson received military advice which was far off the mark in regard to capabilities and timetables." Whether this is indeed the explanation, or whether lack of top-level understanding of the political complexities of Southeast Asia was more important is, perhaps, arguable. On the other hand, if the true military requirements for success of American intervention had been understood at the beginning, some of the political thinking might have been more realistic also.

Dr. Bush minces no words in his criticism of certain industries and their officials. He speaks of "the conviction, which I have held for 50 years, that the automobile industry in this country is half asleep and incapable of effective innovative cerebration . . . To be blunt, I think the men who manage the automobile industry are dumb, from the level of the chief engineers and plant managers up." Rather typically, however, he softens this criticism later by describing some of the difficulties facing radical technological innovation in the industry.

Dr. Bush's fundamentally optimistic spirit, which breathes through the whole book, is illustrated by his observations on the space program. He was originally a strong opponent of the program on the grounds "that the scientific results expected by no means justified the enormous expenses involved, for the program called for spending money we badly needed for other things." However, in retrospect, he feels the program may have justified itself "if it caused us, once again, to have confidence in man's ability to overcome rugged obstacles, and to rise above the sordid, the petty, the commonplace, and the wails of those who tell us we are doomed."

Shiploads of Knowledge

The International Migration of High-Level Manpower: Its Impact on the Development Process

The Committee on the International Migration of Talent (Charles V. Kidd, Chairman)
New York, Praeger, 1970, 738 pp., $22.50

Reviewed by
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Congressional Research Service,
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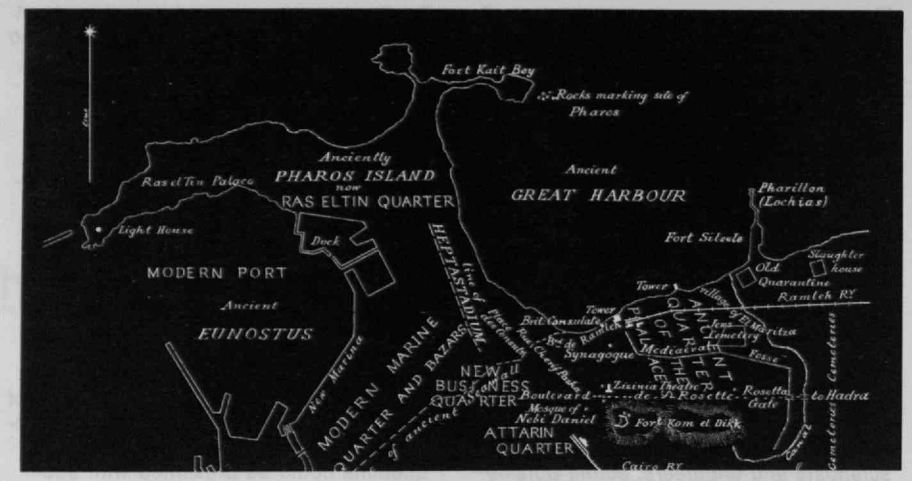

In the accompanying review, Warren R. Johnson of the Congressional Research Service notes that the term "brain drain" was first used by an ancient Greek chronicler in reference to migrations (circa 300 B.C.) from Greece to Alexandria, in consequence of which that city presently eclipsed Athens as the focus of scholarship and knowledge in the then-known world. Alexandria's library is considered to have been the greatest of ancient times; it may have contained 700,000 papyrus scrolls. The city's decline as a center began with its capture by Caesar in 48 B.C., whereupon commenced another—perhaps forced—migration of the intellectuals. (Map from D. G. Hogarth for the Society for the Promotion of Hellenic Studies, 1894)

Before commenting on the merits and possible demerits of this report, let us remember that the subject has a history. Ambassador Nuri Eren, Turkey's Deputy Permanent Representative to the U.N., wrote in the *Saturday Review* for August 2, 1969: "The brain drain, per se, is not new, even though Lord Hailsham was the first contemporary personality to bring it into international prominence some years ago in a statement before the House of Lords in which he complained of the drain of British brains to the United States. But the term as such was first used by an ancient Greek writer, Atheneus, when he wrote of 'the drain of Greek brains to Alexandria.' "

Many writers have cited Alexandria as the outstanding early example of a center of learning and culture which achieved that status as the beneficiary of a brain drain. In *The Brain Drain* (edited by Walter Adams), physicist Stevan Dedijer reconstructs what happened: "The goals of at least the first few Ptolemies were to establish Hellenic culture in Egypt, to surpass Athens itself as its center. . . . They were acutely aware of the service that science could be made to render to the state, not only in providing the most fundamental requisites of civilized life but also in producing bewilderment and awe among the governed."

In his foreword to *The Knowledge Revolution,* by D. N. Chorafas, U.S. Graduate Schools Council President Gustave O. Arlt remarks that without the brain drain from Constantinople which attended the fall of the Byzantine Empire, it would be hard to imagine what the later history of Europe might have been: "The artistic, literary and scientific wealth of the city-state before the disaster was almost inconceivable. The mass migration of intellectuals from Constantinople to Europe was directly responsible for the cultural revival of Europe, for the end of the Dark Ages, for Humanism and the Renaissance."

The development of America in the eighteenth and nineteenth centuries was furthered not only by large-scale general immigration but also by some special migrations of talent. Alexander Hamilton symbolically set the stage in his 1791 "Report on Manufactures" to the Congress by recommending government subsidies "to defray the expenses of the emigration of Artists and Manufacturers . . . ". Robert Owen brought his "Shipload of Knowledge" to establish, in 1825, the town of New Harmony and the beginnings of manufacturing in the region of the lower Ohio River. More important in numbers and significance, as Dr. Arlt observes, was the influx of German intellectuals after the abortive democratic revolution in Prussia in 1848. Another mass exodus of scientists and other scholars from Germany, of which America was a chief beneficiary, was brought about by the rise of Nazism in the 1930's.

Enrichment of the Rich

Today, the special problem which causes concern is the gratuitous intellectual (especially scientific and technological) enrichment of already rich areas of the world at the expense of the struggling poor areas. All kinds of startling statistics can be cited to illustrate the problem.

Ambassador Eren notes that in the four years 1962-66, almost 52 per cent of the engineering graduates of Iran, 14 per cent of the country's scientists, and 10 per cent of its physicians left for work abroad, and that about 36 per cent of Lebanese engineers, 30 per cent of Chilean engineers, 15 per cent of Turkish physicians, and 19 per cent of Filipino physicians did likewise. To cite an even worse case: "The new countries of Africa plagued by disease have been left with a handful of doctors and practically no nurses, while hundreds of their nationals practice in Europe."

The starting point of the Education and World Affairs study was that the existence of an international brain drain was well enough documented, but that next to nothing was known—in systematic, universal terms—about the extent, pattern, characteristics, and consequences of the drain. The purpose of the study was to develop a worldwide view of the character and the impact of the brain drain phenomenon, concentrating on movement from the less developed parts of the world because of the feeling common to all members of the Committee that if any harm was done by migration, it would come from that kind of movement.

The Committee on the International Migration of Talent (sponsored by E.W.A.) was chaired by the (then) Executive Secretary of the Federal Council for Science and Technology, Charles V. Kidd, who is now Director of the Council on Federal Relations of the Association of American Universities. It included George B. Baldwin, economist and development specialist of the World Bank; Frederick H. Harbison, specialist in manpower and human resource development, of Princeton; John L. Thurston, expert on educational affairs in the underdeveloped world, of the Institute of International Education; Dael Wolfle, psychologist with a special interest in scientific manpower and education, of the American Association for the Advancement of Science; and Robert L. Clark (study director), expert on national and international manpower problems.

The resulting book is in the form of a collection of overviews and monographs prepared by individual authors. The overviews discuss regional patterns and

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serve as introductions to the treatments of the countries studied in each region. A final chapter, the product of committee effort and substantial consensus, contains conclusions drawn "largely from the studies, but also [based] on the totality of information available on the subject and on the critical judgments of the Committee members."

One of the Committee's main conclusions makes it clear that the apparently simple question, Is there a brain drain? is highly ambiguous. There is, to be sure —in the basic and not necessarily invidious sense of a net talent migration from certain underdeveloped to certain developed countries. On the other hand, in the usually intended sense of a prime negative causal factor of the development process, there is not.

More Effect than Cause

For the Committee has found that the migration of talent is much more an effect than a cause of underdevelopment. It is a result of deficiencies and imbalances in the talent-exporting areas, more than of attractions in the talent-receiving areas; of "push" factors more than of "pull" factors. A significant related conclusion is that salary is not the most important of the "pull" factors: "Money is undeniably important, but a combination of nonmonetary factors seems everywhere more important. The main nonmonetary factors are opportunities to be creative, a chance to use one's professional training effectively, to work with respected associates, a feeling of usefulness to the community, and a feeling that one is held in esteem. When these needs can be met, highly trained people tend to stay at home. . . ."

The 58-page concluding chapter of the study contains many other observations which will serve as useful guidelines to policy makers and planners of development or development assistance. Among them:

◇ Most countries waste more educated talent by occupational changes, underemployment, and internal migration (particularly from countryside to city) than they do through emigration.

◇ Development seems to be characterized by dynamic disequilibrium, rather than balanced growth. One form that such disequilibrium assumes is an imbalance between the output of highly trained people and the capacity of the economy to absorb them.

◇ It is easier to produce high-level manpower than to build the infrastructure which permits it to be used effectively. There are enormous pressures for higher education in the developing areas and the result is frequently that more graduates are produced than can be absorbed.

◇ As the basic strategy for keeping more of the ablest and most needed specialists at home, both developed and less developed countries need to base short-run measures on long-run objectives: i.e., to concentrate on development goals and to minimize migration controls.

◇ Less-developed countries which have not already done so should consider the establishment of a formal point within the structure of government for the handling of such problems as the promotion of science and technology, the adaptation of technology to solution of local problems, and "the establishment of productive interfaces between higher education, science, and technology."

◇ "Centers of excellence" such as the Indian Institute of Technology, the Korean Institute of Science and Technology, and La Molina Agricultural University in Peru, should be established in developing countries as one of the ways of achieving a "critical mass" of talent.

◇ Specific steps should be taken to reduce migration and encourage the return of talent. "The prime requirement is a job that is suitable in the eyes of the potential returning migrant. A firm advance offer of a specific job with specified terms and conditions of employment is the surest recruitment device."

◇ The first obligation of the *developed* countries is to increase their output of highly trained manpower in fields like medicine. Another is to increase the volume and effectiveness of assistance to the less developed countries. An example of a critically important task which needs to be performed more effectively is that of helping countries establish or reform the institutions which are central to development, including institutes for technology and related management, and the structure and operations of the government itself.

◇ There are widening areas of education, science, and technology which can best be exploited by multinational action. The need for pooling of resources in large international institutions exists throughout the less-developed world. "The Institute for Science and Technology in Bangkok is an early prototype of such an approach, as is the Institute of Nutrition of Central America and Panama."

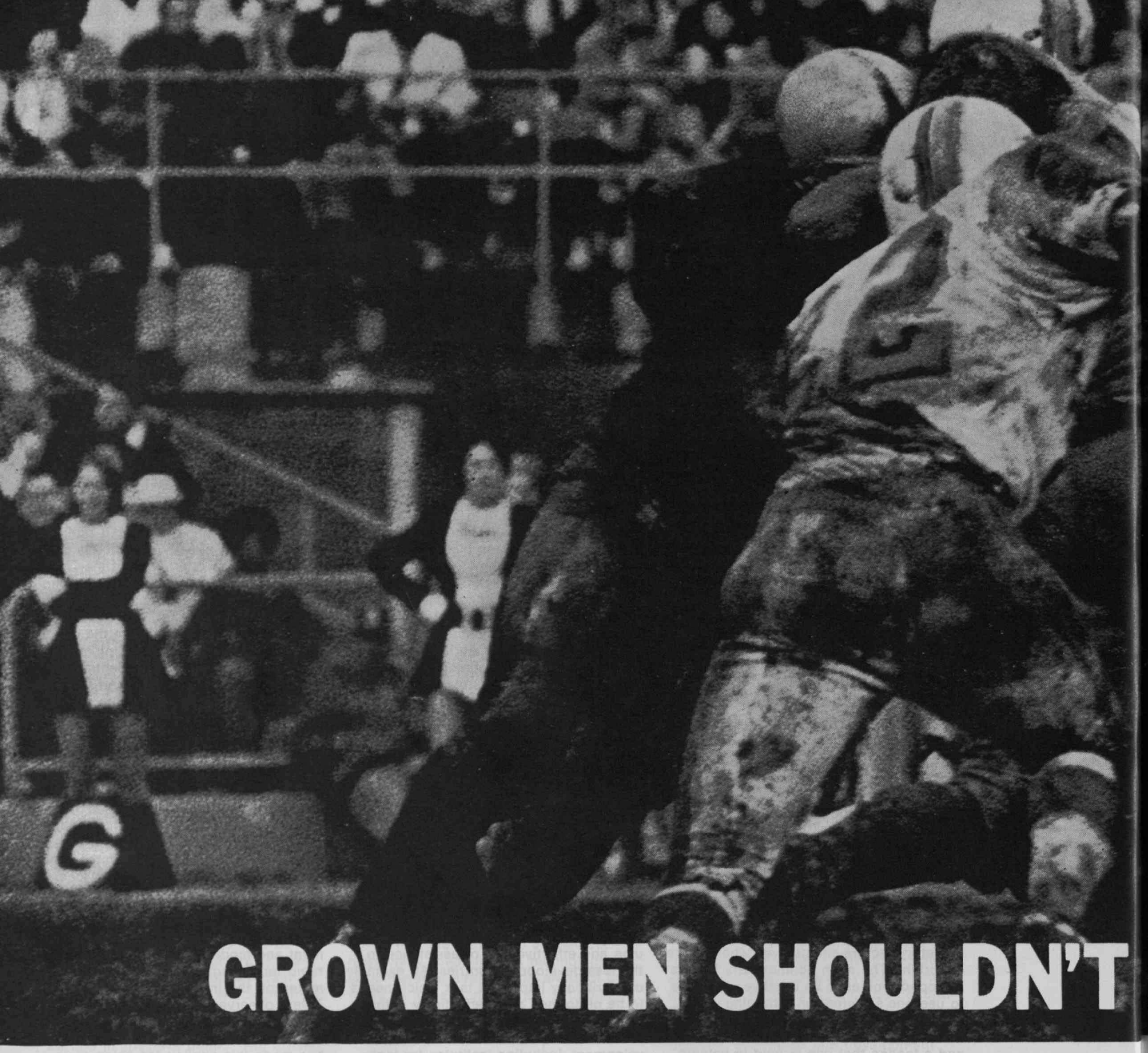
Technology and Diplomacy

The E.W.A. study is not without faults. Over and above some unavoidable unevenness occasioned by the many gaps in available data, it has inconsistencies of treatment, which mainly reflect the preferences of different authors. Of greater consequence, and potentially more disconcerting to the reader, are differences in tone. The feeling in some parts of the study is one of passionate concern and of urgent need for action; in others, of detachment.

Whatever its deficiencies, *International Migration* is an outstanding inquiry into a subject which continues to attract widespread interest. It is particularly timely in that its appearance coincides with the beginning of a review of the brain drain problem, in its implications for U.S. government policy and action, which is being undertaken for the Subcommittee on National Security Policy and Scientific Developments of the House Foreign Affairs Committee. This review is one of 16 projected case studies to be published under the series title "Science, Technology, and American Diplomacy." The series, as Subcommittee Chairman Clement J. Zablocki writes in the foreword to the 69-page annotated bibliography which is already in print, "is concerned with the operations of the U.S. government. . . . in dealing with international issues and problems of a scientific and technical character, with the effect of science and technology on the conduct of foreign affairs, and with diplomatic concerns of international scientific organizations to which the United States belongs." Previous work by the subcommittee, Chairman Zablocki adds, has indicated that in many instances U.S. foreign policy "has lagged far behind technological innovations of worldwide importance. Through this study, we hope to find out precisely what the situation is, and how America's performance can be improved in this vital area."

Most of the 16 Foreign Affairs studies relate in one way or another to the enormously significant, complicated, and uncertain—in some ways threatening—problem of achieving balanced development and modernization in a world of rapid technological change. As the Committee on the International Migration of Talent observes: ". . . the poorer countries have no choice but to modernize. . . . We agree with Gunnar Myrdal, who has made this explicit for Asian countries: 'The South Asian countries. . . have passed the point of no return. Given the present and foreseeable rate of population growth, the choice of remaining traditional societies is no longer open.' We believe that this thesis holds for the entire underdeveloped world. . . ."

The brain drain is a symptom of the imbalance which retards modernization and development. To study it is to gain both an appreciation of its underlying causes, and insights as to what policy and action measures, public and private, are most needed to cope with them. The E.W.A. report provides many such insights, and will command the respect and gratitude of scholars of the development process.



GROWN MEN SHOULDN'T

Soon tests will begin on a bright idea for roofing stadiums with stainless steel balloons. And nickel's helping make it happen.

It sounds like something out of Jules Verne. Actually, it's fresh out of our advanced design studies.

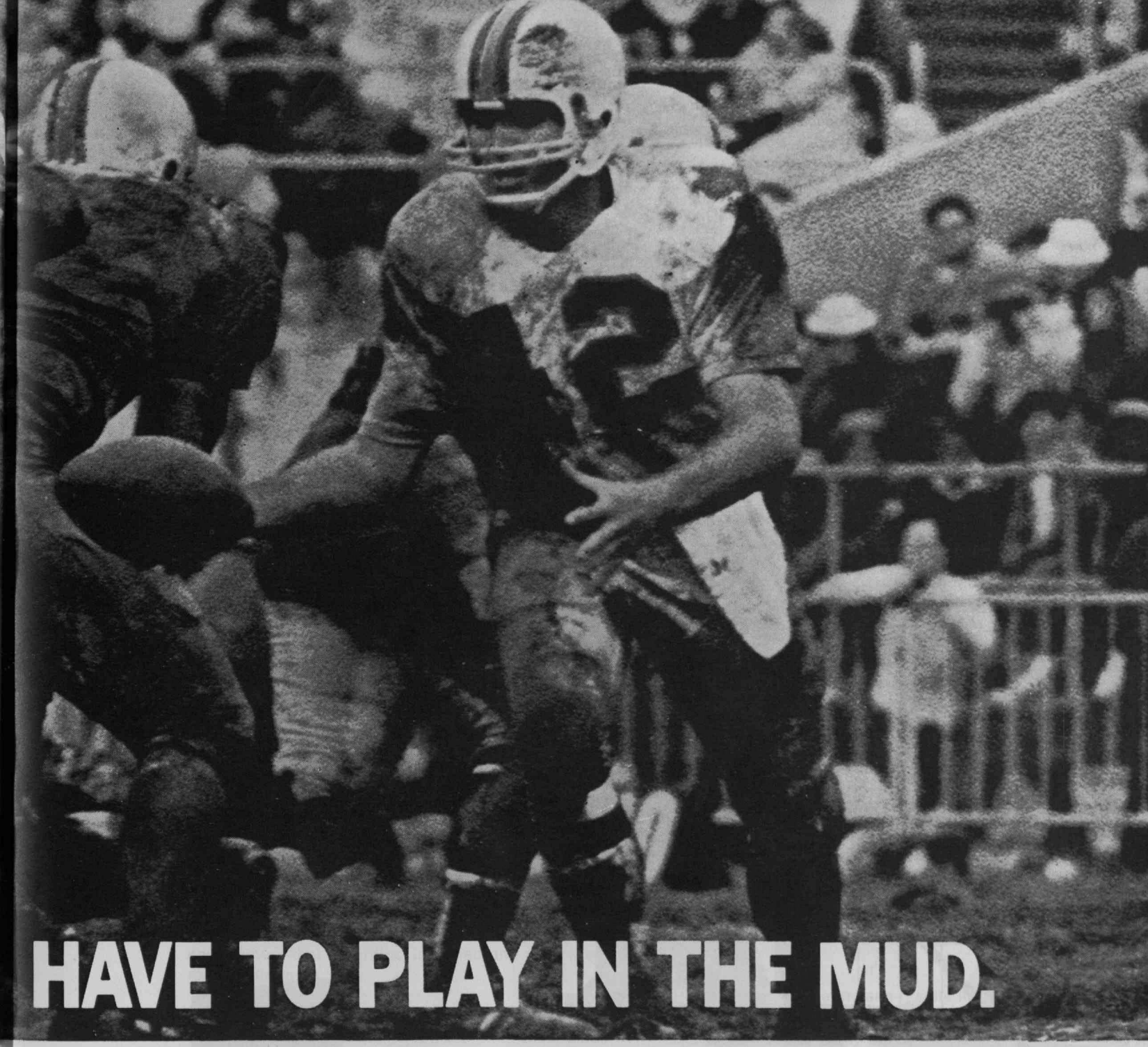
A gigantic, *inflatable* metal lid that can be stretched across a football stadium without any pillars or posts of any kind.

The idea is so mind-boggling that most people have a hard time visualizing it.

Think of a pie that's hollow inside, with the bottom and the top made of a metal skin only 1/16th of an inch thick. When the air is pumped into the pie, the whole thing gets so rigid it can be jacked up into place over the field and never even flutter during a windstorm.

The weather stays outside, the players don't slide around on their backsides, and the spectators don't drown. Somehow, the whole thing seems a little more civilized than a public mud bath.

And the cost could be as little as 1/3 of a conventional trussed roof.



HAVE TO PLAY IN THE MUD.

The metal is nickel stainless steel. The nickel is there to make the skin easier to work, and to give it the necessary toughness and strength. Plus corrosion resistance.

It's a fascinating idea, this revolutionary roof of ours, and scale models are about to be thoroughly tested.

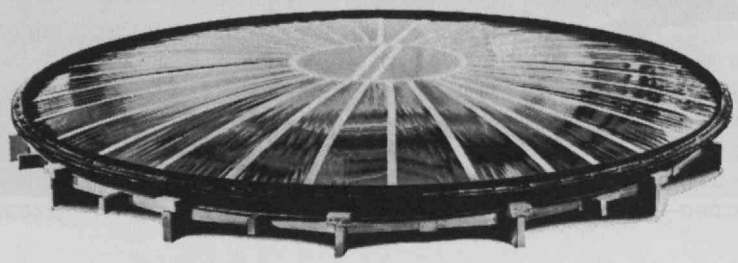
But the point of the story is this. Just as our metal is a helper, one that makes other metals stronger, or easier to work with, or longer lasting, so International Nickel is a helper.

We assist dozens of different industries all over the world in the use of metals. We offer technical information. And the benefit of our experience. Often, Inco metallurgists are able to anticipate alloys that will be needed in the future, and to set about creating them. Sometimes, we come up with whole new concepts—like a stainless steel balloon for a stadium roof.

This kind of genuine helpfulness, we figure, will encourage our customers to keep coming back to us.

And that helps all around.

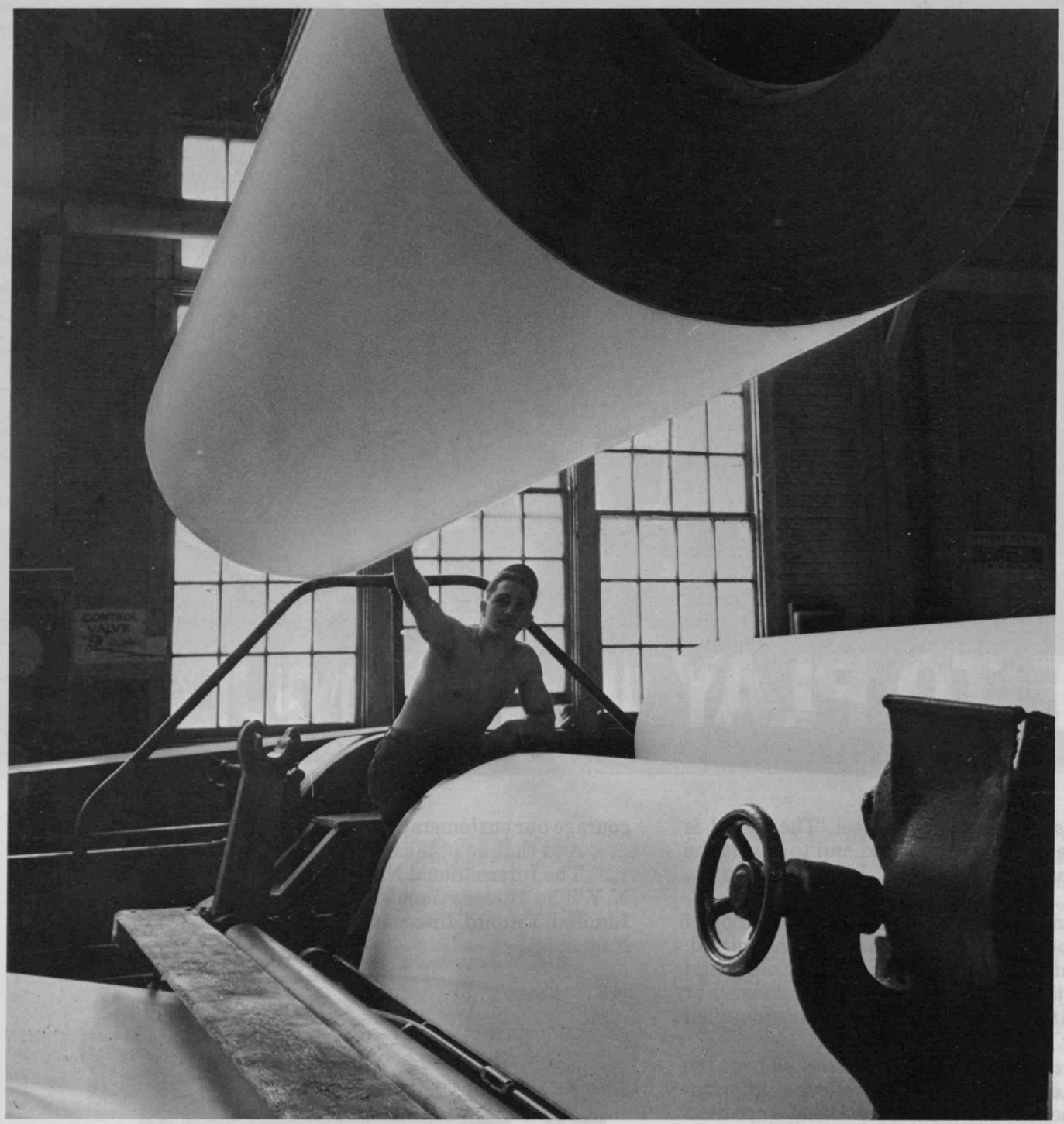
The International Nickel Company, Inc., New York, N.Y. The International Nickel Company of Canada, Limited, Toronto. International Nickel Limited, London, England.



Model test roof of nickel stainless steel.

INTERNATIONAL NICKEL HELPS

"Primed by economic necessity, by public and governmental pressure, and by a developing sense of responsibility to preserve the environment," writes Henry I. Bolker, "a revolution has been in progress for some years (in the pulp and paper industry)." Here is an account of how wood is transformed into paper—and about how the noxious by-products of these remarkable processes can be dealt with.



The pulp and paper industry is often called to account as a principal polluter of water and air. Its technology presents multiple opportunities for fulfilling that citation and—more recently—for refuting it

Henry I. Bolker
Pulp and Paper Research Institute of Canada and
Department of Chemistry, McGill University

Out of the Woods

In the eyes of the public, the pulp and paper business is hardly a glamor industry. Its basic processes were invented in the nineteenth century and have but slowly evolved to their present technological state. Its ground-rules were laid down in another era, long before the current concern with hazards of our environment—an era when everyone assumed that any and all unpleasantnesses could be diluted to negligibility by the vast quantities of water and air in the world.

But now we have learned to measure things and to worry about mercury in parts per million and organic sulfides in parts per billion. We have also experienced radioactive fallout, DDT, thalidomide, and cyclamate. We have become sophisticated enough to recognize that certain substances, originally released in innocent parts per million, pass upward through food-chains and become concentrated to deadly parts per thousand; that certain other substances cause fetal malformities; and that yet others, given enough time, cause cancer. We have learned that every human activity, even love, has its by-products, many of which bode ill for the future of mankind in a crowded technological world.

In today's atmosphere of charges and denials, it may be calming for the nerves to look dispassionately at the paper industry to see how it functions and whether it must continue to be the arch-despoiler of the environment that its critics, informed and otherwise, make it out to be.

Except for the recycled paper which yields a product suitable for only limited end uses, and the small amount of rags converted into special fine papers, most of the industry's raw material comes from forest trees. First with axes, then with power saws, and now with mobile mechanical monsters called "full-tree-loggers," the industry has reaped its annual harvest for nearly a century. Sometimes the woodsmen cut selectively—a tree here and a tree there; more often they practice clear cutting, removing all the trees from an area of several acres. They leave behind the "slash"—the branches and twigs—and transport only the logs to the mill.

Once at the mill, the wood is converted into pulp by one of several processes, each of which yields pulp of different characteristics for one of a considerable variety of ultimate end uses. Whatever the process, the first step—removing the bark—is common to all. From the barking plant, the wood moves on to the pulp mill proper, where either mechanical or chemical treatment will separate its natural fibers so that they may ultimately be reformed into paper sheets.

Making Pulp and Paper

Rendering wood into pulp is by far the most complex—and least understood—of the processes involved in papermaking. Both mechanical and chemical processes are available; though there are significant differences between them, the result of all is a fibrous, cellulosic material which represents between 50 and 70 per cent of the original wood. The balance is degraded and carried away in solution.

Of the various pulping processes, the mechanical process is, in principle, the simplest and most economical, producing a pulp called "groundwood" and the paper of least strength and permanence that is most familiar to us in the form of newsprint. In mechanical pulping, the four-foot logs are simply pressed lengthwise, in a shower of water, against a rapidly moving grindstone whose face is scored with a particular pattern. The resulting porridge-like mixture may sometimes need slight bleaching (especially if made from certain species on the West Coast), but usually, with some chemically made pulp added, it is ready to be made into paper.

Pulping by chemical means results in more stable and stronger pulps than can be obtained mechanically, but yields are generally lower. The applicability of chemical methods arises from the structure of the wood itself whose fibrous cells, with their long axes oriented in the same direction as the tree trunk, are held together by an amorphous matrix of polymeric materials.

The principle substance of the cell wall is cellulose, a polymer composed of long molecular chains linking as many as 10,000 units of glucose; it also contains hemicelluloses and lignins. Hemicelluloses are polymers with shorter chains, often branched. Some contain glucose, but they are mainly composed of other natural sugars. Their composition differs from genus to genus; broadly speaking, the hardwoods and the softwoods each have a characteristic, though different, mixture. Lignin is another sort of polymer entirely, based on building blocks of phenyl-propane groups—benzene

The pulp and paper industry's waste problems begin in the forest, where slash may appear to be a more serious form of waste than in fact it is. Professional foresters are employed by all responsible mills, and their task is to assure that optimum conditions for reforestation exist after the crop has been cut.

rings bearing 3-carbon side-chains; its molecules are three-dimensional networks—a molecular monkey-bar. Between the lignins of hardwoods and softwoods, the details of molecular structure are sufficiently different to make them different in chemical reactivity.

The amorphous substance between the cells is a mixture of lignin and hemicellulose, but mostly lignin. The several processes of chemical pulping degrade and dissolve away the lignin of the intercellular spaces, thus permitting the fibers to separate from each other without themselves undergoing the damage that they suffer in mechanical pulping. Nevertheless, the fibers do not emerge entirely unscathed, for it is inevitable that the process which delignifies the intercellular region should also delignify the cell wall. Hemicelluloses are also removed from both the cell wall and the intercellular spaces. The cellulose itself is somewhat damaged by chemical pulping—more by acid processes than by alkaline—and the damage reduces the strength of the ultimate product.

From the economic point of view, the most important method of chemical pulping is the technique called the kraft process. The pulp is the strongest produced from wood fibers; it is dark in color (grocery bags and corrugated shipping cartons are familiar examples) and originally was difficult to bleach. Once the industry learned how to bleach it, the production of kraft pulp began to expand rapidly, and the product now constitutes about two-thirds of all the pulp produced in the United States.

Wood for the kraft process must first be chipped—cut into pieces about 2 inches long, an inch and a half wide, and ⅛ to ¼ inch thick. The chips are then cooked with pulping liquor at high temperature and pressure. Many mills still cook their wood batchwise in huge digesters, but continuous processes have become available and are generally to be found in the newer mills.

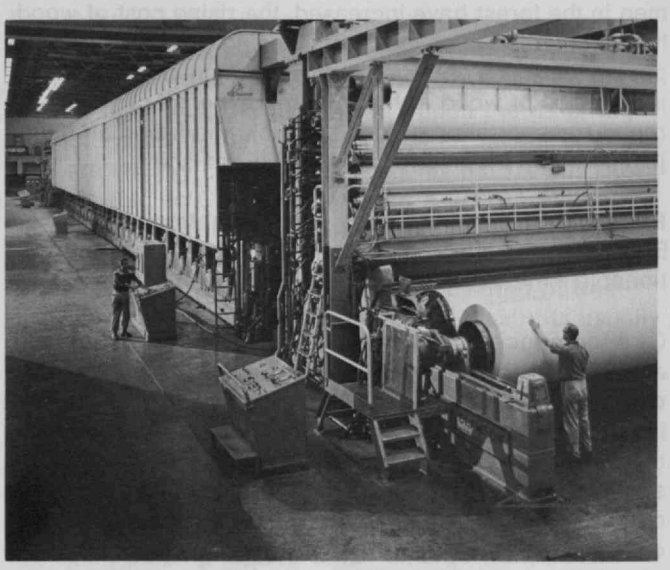
For those of us who are committed to the notion of the near omnipotence of modern science, it may be chastening to contemplate that after nearly 100 years of using and studying the kraft process, we do not yet completely understand its complex chemistry. The composition of the cooking liquor is simple enough: a solution of sodium hydroxide and sodium sulfide. A significant feature of the process is that these chemicals are recovered by burning the organic components of the used liquor, and the recovery is essential to economical operation. Recovery comprises several stages, and on a flow-sheet it appears that there is more chemical engineering in the recovery cycle than in the pulping process itself.

Such recovery of chemicals is not readily possible in the common version of the acid-sulfite process. Its cellulosic products are weaker than kraft pulp, but they have special properties which make them useful as a component in newsprint and for the manufacture of fine papers. In highly purified form sulfite pulp is used for the manufacture of chemical products such as nitrocellulose and the fibers and films we know as rayon and "Cellophane," as well as less well-known derivatives which have a number of industrial applications.

A modification of the sulfite process, called neutral sulfite semi-chemical, a combination of chemical and mechanical pulping, is now gaining favor. In it, chipped wood is cooked and thus softened in a neutral solution of sodium sulfite, with the loss of a small fraction of its components; it is then soft enough to be ground ("refined") between rapidly counter-rotating abrasive discs. The neutral sulfite process yields more pulp than conventional sulfite methods, and—as in the kraft process—the organic components of the spent liquor can be burned to permit recovery and re-use of the pulping chemicals.

By whatever process it is made, sulfite pulp is generally lighter in color than kraft and can more often be used in an unbleached state. And when it is to be used, for example, for the manufacture of fine papers, sulfite pulp can be bleached fairly easily. However, it is worth noting that bleaching any cellulosic pulp is a touchy process, because, used to excess, the bleaching chemicals can damage the cellulose and weaken the pulp. For this reason, bleaching of both sulfite and kraft pulps is generally conducted in several stages—a time-consuming and relatively expensive procedure. Chlorine and its derivatives provide the most common bleaching agents, although hydrogen peroxide is sometimes employed.

Rendering wood into pulp, and then bleaching and processing the pulp (left) into a suitable base for paper, is the source of the most serious waste problems in the papermaking process. The waste liquor contains surplus fibers—relatively easy to deal with—and sulfites in solution—much harder. Machines on which the pulp is formed into the thin sheets such as those in the reader's hands (right) yield surplus fiber but few other wastes. (Photos: Malak (Ottawa) and Gilbert A. Milne & Co., Ltd., from the Pulp and Paper Institute of Canada)



Bleached or unbleached, kraft, sulfite or mechanical, most pulp that is to be made into paper undergoes its conversion on a machine whose basic principle was invented in 1799. At one end, a thin slurry of pulp falls on a rapidly moving and vibrating endless screen; as this slurry is carried along, its fibers form an interlinked, multilayered web and it loses enough water so that, by the time it reaches the other end of the screen about 50 feet away, it is strong enough to cross a small gap and enter a dryer. Here the paper, held in place by an endless belt of felt, passes over a long series of heated rolls, and most of its residual water evaporates.

Conservation and Pollution above the Mill

Of course, it is the materials that never get to the market that concern us nowadays—the parts that go up the stack or down the drain. The papermaker is also increasingly concerned with what some have called the "rape of the forest," for Americans' mobility and desire for outdoor recreation are bringing more and more of them into contact with the sources of his raw materials. Large areas cut from the forest may look to most people like the result of ponderous irresponsibility, but the fact is that all the wood for the industry is cut under the supervision of professional foresters.

Such a professional forester serving as the woodlands manager of a pulp company has a dual responsibility: He must assure his mill of an adequate supply of wood of high quality at an acceptable cost, and he must look to the future supply, taking the actions necessary to supplement the natural processes of forest regeneration. His concern is for an ecosystem. He must take advantage of the natural forces which will come into play to establish equilibria anew and assure that the entire system is not ruined. Before he permits harvesting, he surveys the forest floor to determine the regenerative potential of the land. Seedlings of the desired species already growing or seed present in the humus provide reasonable assurance that the area may be clearcut. If conditions do not favor natural regeneration, the forester will employ replanting as a means of reforestation. In either event, it is generally true that, with the competition of large trees removed, the seedlings grow rapidly to yield a clean, homogeneous forest of high quality. Let the casual traveller beware of his first judgment when, passing near a recently cut area of forest, he sees only the slash left behind by the woodcutters; the future is well provided for. The forester—and the industry in which he is employed—know that costs can only be kept competitive if, after a period of time, the manufacturer can return to an area of cut forest and cut it again.

To some degree, the foresters are also responsible for the waterways within their jurisdictions. This is especially true in those areas where rivers are used to deliver logs to the mills by log-driving—the most colorful of the industry's traditions. The principal environmental problem raised by log-driving is that bark is

abraded from the logs. Another problem is "sinkage," the loss of a certain small portion of the logs which absorb water and sink. Sinkage is wasteful in terms of the value of the wood lost. It is also believed to be polluting because the sunken logs, along with the abraded bark, decomposing at the bottom of the river, may make a significant demand upon the available oxygen, decreasing the capacity of the water to support plant and animal life.

The river-drive, never a major activity in the United States, is still significant in certain parts of Canada, where the distance from woods to mill is sometimes so great that log-driving is the only economical means of transport. But the force of present-day economics is changing the old tradition. As the wages of workmen in the forest have increased, the rising cost of wood has become a major factor influencing the cost of paper; there is a strong incentive to maintain minimum inventories of wood at the mill; the expense of year-round transportation of logs by truck and train can be justified; and the river-drive is slowly vanishing.

Papermaking and Mercury Contamination

But will economics clear the waterways of other objectionable materials?

Of three principal man-caused sources of mercury in the aqueous environment—chloralkali operations, slimicides, and seed dressings—the paper industry has been involved only in the first two—and in those in only a minor way. Its greatest error was to use organo-mercury slimicides in its mills to stop the growth of slimy molds on paper machines; use of these slimicides has now declined, for reasons other than pollution control, and what little use remains will soon vanish.

The mercury from chloralkali operations is another matter. Ten per cent of the total production of sodium hydroxide in the United States and 17 per cent of the chlorine are destined for use in the pulp industry, and it is clear that metallic mercury in discharges from chloralkali plants is entering the foodchain, apparently through the action of microorganisms which convert it into soluble organic derivatives. Fortunately, no more than 20 per cent of the electrolytic caustic-chlorine capacity comes from mercury cells. Most of the rest is made in mercury-free diaphragm cells. Commercial sodium hydroxide itself does contain about one part per million of mercury. As used in paper mills, this mercury is so greatly diluted in the process waters that its presence in effluents is measurable only in parts per trillion. But one of the paper industry's own chloralkali manufacturers, operated by the Georgia-Pacific Co., has developed and put into use at its plant at Bellingham, Wash., what it describes as a "total recycling system" that eliminates even traces of mercury discharge from the plant product and its effluent.

Fibers as Pollutants

With respect to pollution by mercury, the paper industry can share the blame and the problem with others. But it stands alone with most of the rest of its problems concerning pollution by effluents. With all the abrasion —the barking and the grinding as in mechanical pulp manufacture—and the draining steps in the making of chemical pulp and in the formation of paper, a good deal of solid material must, and does, go down the sewer.

The large chunks from the barker are not much of a problem. They can be easily recovered. There is even a hope that some day this waste material, after treatment to make up its deficiency of nitrogen, may prove useful as a fertilizer and soil amendment. A few firms are already selling some of their bark for horticultural use, most successfully in California, but only extensive use of bark in agriculture could take up a significant fraction of the quantity available on a national scale. For the present, most of the bark is a total waste, to be burned in the power plants of those mills that use solid fuel or to be trucked away for land-fill from those that burn oil.

The salvageable fibers are not much of a problem either, for most are screened out and sent back to the process.

The real problem with respect to suspended solid materials is in those portions too fine to be caught in mesh screens—so fine, indeed, as to clog filters.

"Fines" of this nature come from all parts of the process—barker, pulp mill, paper mill; and in freer days they were simply discharged into the local receiving waters in the expectation that nature would look after them by dilution and biological oxidation. The industry now knows, to its cost, that this simple solution is plainly inadequate. The part that is diluted is carried away from the mill and fed on by microorganisms; their very feeding and growth consumes oxygen from the water, whose capacity to support normal plant and fish life then becomes depleted.

The part that is not diluted remains in the vicinity of the mill's outfall and gradually builds up to an intractable, gelatinous, rotting underwater mountain. This is the problem which has achieved recent national publicity in Lake Champlain; the Associated Press described "a million and a half cubic yards of paper mill sludge, nearly half the bulk of the Great Pyramid of Egypt, . . . a putrid delta (which) boils and stinks like a witch's cauldron in the summer, consuming the oxygen of the lake as it decays."

Every new paper mill is now being equipped with facilities to remove solid and other wastes before water is returned to the land, and older mills are also acquiring suitable facilities—mainly in the form of large settling tanks where the water can be clarified and secondary aeration systems to reduce the biological oxygen demand.

An $8.5 Million Sulfite Solution

Waste materials in true solution constitute a different problem. After separation of the pulp fibers, the spent liquor from a sulfite cook contains lignosulfonic acid (derived from lignin in the original wood), degraded carbohydrate polymers, and free sugars, as well as some residual bisulfite.

If the base is ammonium, sodium, or magnesium, the organic materials, after concentration, may be burned and the pulping chemicals may be recovered and re-used. However, if the base is calcium, such recovery is not economically possible. Nevertheless, a number of processes have been developed over the years to permit the isolation of useful by-products from the organic fraction. In one such process, the lignin in the waste liquor is oxidized to produce vanillin, the common flavoring agent, at a cost much less than that of the extract of vanilla beans. The recovery of vanillin from waste sulfite liquor has been practiced since the 1930's, but it is not applicable in all mills simply because the market for vanillin is measurable in pounds, while the quantity of lignin available is measured in tons.

Another procedure of limited applicability is to precipitate the lignosulfonic acid and to modify it for various end-uses: as a water-proofing sealant for concrete structures, as a component of oil-well drilling fluids, as an agent for treating boiler water, as a soil stabilizer, as a dispersing agent in textile dyeing and finishing, and even as a binder in animal feeds. Again, although the consumption of lignosulfonic acid in several of these end-uses is growing rapidly, the total market does not amount to more than a small fraction of the available raw material.

A few mills are in a position to take advantage of the sugar content, rather than the lignin, in the waste liquor, fermenting it to produce alcohol. They also make bakers' yeast and torula yeast for animal feed.

However, even after some materials of economic value have been recovered from the liquor, the rest must generally go back to the land and, inevitably, to the rivers and lakes.

The pressure to eliminate this source of pollution has been exerted by some state governments for longer than most people realize, and in consequence some companies have sought and found unique solutions. One such is the Hammermill Paper Co. which, at its Erie, Pa., mill, drilled two deep wells, one 1,600 feet deep, the other 5,972 feet. Waste liquors, suitably prepared, are injected into these wells, where they are absorbed into porous rock formations. Unfortunately, this is not a universal solution to the problem of disposing of waste sulfite liquors. Few engineers are happy about the system's high probability of plugging, and few mills are located on or near appropriate geological formations.

Instead, most mills must turn to other, more elaborate purification units—such as one mill recently announced. For $8.5 million this company will install a three-unit system: a clarifier to remove 8 tons per day of fiber from the effluent, an ion-exchange plant to remove 40 tons per day of dissolved solids (in part re-usable), and an evaporating and burning installation to eliminate foam and color.

Kraft and Bleach Effluents

To some degree, the kraft industry shares certain problems of abatement of water pollution with the sulfite industry—such as solids in the effluent waters. Occasionally an odd problem crops up, as happened to a mill situated on a famous salmon-fishing river in New Brunswick. No matter what the plant engineers did to clean up the effluent, the very young salmon, which are quite sensitive, were dying in the vicinity of the mill. Evidence accumulated to indicate that only the water from the chlorination stage of the bleach plant had this disastrous effect. Patient scientific detective work ultimately revealed that one simple chlorinated organic compound, tetrachloro-o-benzoquinone, present in only small amounts, was the source of toxicity. All that needed to be done was to treat the water with a little sulfur dioxide, and the offending compound was rendered harmless.

Bleach plant effluents and the wash waters from other parts of the mill are otherwise generally innocuous and dilute enough to be disposable without placing an undue load of biological oxygen demand upon the receiving waters. However, they cause protest for another reason: they are slightly colored. Relief seems not far off. The Georgia-Pacific Co. has developed a lime-recycling process which it claims to be 90 per cent effective in removing color. It is too early to say whether the rest of the industry will rush to adopt this method of treatment. If the past is any indicator, the industry is usually cautious about new techniques until they have been well proven at several mills. However, the current external pressures may be changing this conservative attitude.

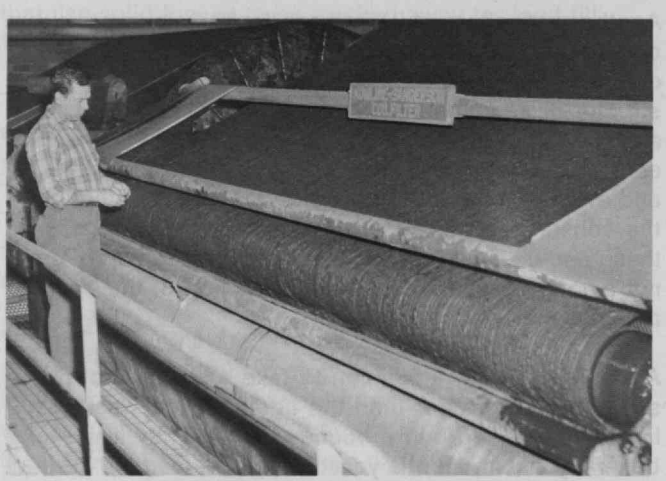
Atmospheric Pollutants

The most massive load of potential water pollution from kraft mills—the degraded lignin and carbohydrates in the spent pulping liquors which emerge from the digesters—is kept out of the nearby waters by being burned in the recovery furnace. Unfortunately, when the hot liquors are first released from the digester, and again during the burning process, small quantities of volatile, malodorous compounds escape into the atmosphere: hydrogen sulfide, methyl mercaptan, dimethyl sulfide, dimethyl disulfide, and the like. These are the compounds that give the air in and around kraft mill towns their characteristic odors. Not to put too fine a point on it, most people think they stink.

Offensive as they are, these gases, at the concentrations found even close to the mills, do not seem to be toxic. If there is any evidence of human or other life having been shortened by exposure to these gases at their usual concentrations, I have not been able to find it. The objections have their basis more in esthetics than in toxicology, and reducing the offending odor is not made easier by the fact that the human nose can detect the responsible compounds in concentrations of five parts per billion.

It is such odors that constitute a major target of the various "Clean Air Acts." One government has taken a different and seemingly eccentric step. In February, 1970, the Canadian province of British Columbia offered $250,000 to the first firm or individual to install in the province a mill that effectively and economically removes odor from the kraft process. It goes without saying that such a process will be made mandatory in all the

Sludge—a composition of surplus fiber, sand, grit, and other waste solids—is a principal waste product of every pulp mill. Modern practice is to separate the sludge from the water in which it is carried from the pulp process (top) and haul it to disposal areas for burial where oxidation can proceed without danger to surface waters. (Photos: Burr Studio, Covington, Ky., from Westvaco)



mills in the province as soon as it is proven.

Whether he knew it or not, Mr. W.A.C. ("Wacky") Bennett, the colorful Premier of British Columbia, was acting in a noble tradition. In 1854, when the demand for paper began to exceed the supply of rags, which were at that time the only raw material, one London newspaper offered £1,000 reward "to any person who shall first succeed in inventing or discovering the means of using a cheap substitute for the cotton and linen materials now used by paper-makers. . . ." However, Mr. Bennett and his money may soon be parted. The American Can Company has recently opened a mill at Halsey, Ore., which meets such rigid antipollution standards that it is acclaimed as setting the norm for all new mills to be constructed in the near future.

It includes odor-control techniques which involve collecting the volatile organic sulfides and leading them to the lime kiln where incineration converts them into sulfur dioxide, a gas to which the nose is much less sensitive. Indeed, the Halsey mill is said to meet, and in some instances even surpass, all the standards of the state of Oregon for air and water quality. The standards are stringent. They have been established in terms of numerical limits; but for the time being, these limits can be no lower than the capacity of analytical instruments to measure them with reasonable accuracy. They are still within the range of a sensitive nose.

The major source of volatile organic sulfides in most mills appears to be a direct-contact evaporator in the recovery furnace. The engineers who designed the mill at Halsey attacked this problem by eliminating the evaporator and redesigning the furnace. With the new design, the recovery furnace, properly operated, should emit less than 1 part per million of hydrogen sulfide, and organic sulfides in smaller, almost immeasurable, quantities. Since emission from a well-designed stack is diluted about a thousand-fold by the time it reaches ground level, the 1 p.p.m. of hydrogen sulfide becomes 1 part per billion, and the organic sulfides even less. In principle, there should be no odor. Nevertheless, *Paper Trade Journal* cautiously described the kraft odor from the mill as being reduced to a "*barely* noticeable level" (my italics). Not having visited the site, I am uncertain of what "barely" means in this context.

If total success is not achieved, it is hard to imagine

why; because, with the major source of malodorous emission under control, the Halsey engineers went after the minor ones. They put hoods around a number of pieces of equipment to collect and vent the volatile substance to the lime kiln. There is even an alternative system of vents to be used in case the lime kiln happens not to be in operation; the gases are then led to the hottest part of the recovery furnace for incineration.

Extra care was also used in designing the system for collecting the particulate matter from the flue gases. A two-chamber precipitator of 99.5 per cent efficiency collects the ash—mostly sodium sulfate—which can be sent back for re-use in the cooking liquor.

From Woods through Mills to Customers

None of the steps taken at Halsey represents any new scientific discovery—simply an impressive attention to detail in engineering. The achievement has been recognized locally by the Engineering Consulting Engineers Council of Oregon having granted the Excellence Award for 1970 to Sandwell International, the firm which designed the mill. The project is being submitted for competition on the national level in 1971.

Indeed, in terms of money spent and committed, the paper industry as a whole may not be doing too badly at all. The Council of Economic Priorities has concluded that the industry will have to spend $750 million to meet "acceptable pollution control standards." Barry Commoner, justly famous for his efforts to make the public aware of pollution and its consequences, has expressed the financial requirement another way. He has said that to meet federal standards for water purity alone would cost the paper industry one-third of its profits for the next ten years. The industry's own published figures are that to the end of 1969 it had spent $667 million on pollution abatement—$500 million for improving its effluent water and $167 million for reducing the gases and particulate solids it releases into the air. The industry projections for the *three*-year period of 1970-72 are an additional $436 million for the control of water quality and $90 million for air quality. As a specific example, the Scott Paper Co., whose total earnings were $60 million in 1969, has announced plans to spend $85 million on pollution-control measures in the years from 1970 to 1978. The International Paper Co. has announced its intention to spend $101 million in executing a "four-year plan to combat pollution" (1970-1974). International's total earnings were $115.6 million in 1969.

In the battle for public favor, publishing large numbers seems to be a recurring response to criticism. Yet, some senior executives in the industry wonder if there is any use in publishing them other than self-satisfaction. One newly appointed Vice-President-in-Charge-of-Environmental-Control (a new but rapidly proliferating occupation in the paper industry) has said that quoting the large sums of money spent does not seem to have much effect on the level of pressure from the public or the media. The general reaction, he said, is, "It's about time."

Some people within the industry itself share the public response. Yet one might expect insiders to realize that such expenditures represent near-traumatic decisions for their directors. Some of the younger technical managers, eager for change, have often in the past secretly or openly suggested that there were troglodytes in the board-rooms. But the pulp and paper industry has a long history quite unlike that of the newer industries based on science and technology. Rather, as a mature commercial enterprise, locked in a price structure established in a more leisurely era, it has proportionately less financial resources than the newer businesses to risk on major revolutionary technological ventures.

Nevertheless, primed by economic necessity, by public and governmental pressure, and by a developing sense of responsibility to preserve the environment, a revolution has been in progress for some years. It reaches from the woods to the mills and all the way to the consumers who may find a role to play in the recycling process—as well as in helping to pay the Council of Economic Priorities' $750 million.

Henry I. Bolker is head of the Organic Chemistry Section of the Pulp and Paper Research Institute of Canada and Research Associate in the Department of Chemistry at McGill University. He is Chairman of the Education Committee of the Canadian Pulp and Paper Association, Vice-President (representing North America) of the International Coordinating Committee for Out-of-School Science, and a member of the Board of Directors of the Conseil de la Jeunesse Scientifique (Quebec) and of the Youth Science Foundation (Canada). For the latter he directs the publication of the quarterly Science Affairs. *He is currently writing a textbook on the chemistry of natural and synthetic polymers.*

For a quarter of a century U.S. science has been built on an extension of the simplified assumptions which governed it in World War II. That system is now obsolete. The central issue today is how the social and physical sciences can maintain their strength while confronted with political reality

Don K. Price
Dean of the Kennedy School of Government
Harvard University

Science at a Policy Crossroads

When Senator Fred Harris set up a series of hearings to consider the creation of a National Social Science Foundation in 1967, spokesmen for the Social Science Research Council and other scientific societies were, in considerable majority, decidedly cool to the proposal. The reasons for their caution seem much clearer now, as a result of the 1970 hearings by Congressman Daddario's subcommittee reviewing the course of national science policy since the second World War.

For the 1970 hearings suggested that the national policy for the support of science that had made the research establishments of the country so fabulously prosperous was no longer politically viable—and for reasons that seem particularly ominous to the social sciences. The reasons have to do with the relation of political purpose to scientific knowledge, a relationship which in the social sciences is especially tricky. The social scientists were tempted by the notion that, as the nation's attention turned from foreign and military to domestic and welfare problems, the affection of appropriations committees would be transferred from physicists and chemists to sociologists and economists. But there were good grounds for skepticism. For, unfortunately, the political forces that proposed in principle to harness social science to liberal purposes are characteristically less disposed than reactionary militarists to understand the essential conditions that let scientists make an effective contribution to practical problems.

This problem is rooted in the theoretical relationship of science to politics, and it also involves the revolutionary intellectual movements that now receive the anxious attention of even the least intellectual politicians. It therefore merits consideration by scientists of all disciplines and politicians of all factions.

We must start by reflecting that the more we have obtained what we wanted, the more unhappy we are. If we had been asked to define our goals for science a generation ago, we would have asked for government support of science so that we could advance basic knowledge, multiply the number of high quality research institutions, educate more competent scientists, apply their findings more effectively to practical ends, and perhaps even persuade scientists to take a greater interest in political and social problems. The most visionary prophecies of 1945 are overwhelmed by the accomplishments of 1970. But science is now expected to do more than produce knowledge and teach it to students: it is expected to help decide the policies of governments. And the more our old policy succeeds, the more new problems scientists seem to create for society, and the more old politicians and young radicals alike demand that science do something about it.

When our postwar policy was devised, not many could foresee all this. That policy was based on the wartime breakthrough; its key was the decision by the leaders of our major institutions in the natural sciences that private institutions should seek the support of federal funds, including military appropriations. During the New Deal period, the idea that federal grants might be made to support private research seemed immoral and unconstitutional. But after the war, at a time when socialist governments abroad were building up their own research laboratories and thus taking talent away from universities, the United States government was persuaded to contract out to universities nearly all of its basic research, and to industry and universities most of its applied research.

In the afterglow of a great victory, it seemed obvious that science and technology would guarantee material progress if given public support in a mixed economy. The specific source of the funds would not matter much; if Congress found it politically easier to bury appropriations for science in the big military and atomic energy budgets, that would not cause any difficulties, since basic knowledge—and even engineering techniques—could be converted from military to civil uses just as readily as they had been mobilized in the opposite direction after Pearl Harbor.

But a vague and impalpable change in attitude toward science and technology has now taken place. Generally throughout the world, but especially in the United States, the most vociferous attitude toward science and technology is no longer one of awe or worship, but of fear and hostility. This is a major part of the new radicalism, and one that has little to do with the old radicalism; the Marxists were as eager as Jeffersonians to believe that science was the key to progress. But the new radicals are not interested in material progress, and they are dead against the influence of science and technology on the way we organize our society and

deal with our problems. For them, these are the gods that failed.

The views of the doctrinaire radicals may not be of much account, but eminent politicians and educators who deplore such radicalism in theory are now taking policy decisions that seem to be motivated by the same basic change in mood. An Appropriations Act of Congress in 1969 forbade the use of military funds for general basic research; university presidents squirm out of arrangements for the sponsorship of strategic studies; government contract officers quarrel with the use of public funds to pay salaries in private research institutions above the civil service scales; and a great variety of voices rise from within the bureaucracy as well as from private pressure groups to protest any technological projects that would, even while adding to the G.N.P., pollute the environment or degrade the quality of life.

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All these portents suggest that the legislative and administrative arrangements that were adopted to support our general science policy between 1945 and 1950 are no longer tenable. Those arrangements, expressed crudely, were to support most basic scientific research through funds appropriate for quite practical national objectives—military power, space exploration, medical care; to billet research projects, so to speak, on universities without accepting federal responsibility for the general support of the universities or asserting federal authority over their internal administration; and to look to scientists and their professional colleagues (such as engineers, physicians, and systems analysts) for solutions to the big problems. For their period, these arrangements were an ingenious and effective policy, and we should be proud of them. But for the future, I fear we cannot support science, and use it for its highest and most humane purposes, without a better policy.

Nevertheless, I am not optimistic about the outcome; I fear that the most ardent critics of our present policy, if they have their way, are likely to get a worse policy rather than a better one. The critics are, of course, by no means of a single mind. But many of them attack the old policy for reasons that would make it impossible to build on the positive accomplishments of the past quarter-century.

The most significant development of the second World War was not the technology involved in radar or the atomic bomb; it was the administrative system and set of operating policies that produced such technological feats. And it was not merely a matter of money; it was the adaptation of this system for civilian science through the Office of Naval Research, the National Science Foundation, the National Institutes of Health, the Atomic Energy Commission, and the National Aeronautics and Space Administration that produced the strengths of American science over the past generation.

As we turn the primary emphasis of that system of policy and administration from military to civilian hands, we had better not destroy those aspects of the system that made it work, simply because they were initiated

for military purposes and under the pressure of a war emergency. For it was only those extraordinary circumstances that made it possible to cut against the grain of our political habits and prejudices in ways that we should have done much earlier, and should now still do.

Let me explain these comments by taking up in turn the three aspects of our recent science policy previously mentioned; for brevity I will label them the relation of science to (1) technology, (2) education, and (3) politics.

Science and Technology

We need to remind ourselves—because it is not easy to remember—that in 1940 the leaders of American science did not want federal money for basic research. Five years later the lesson of the War was clear: basic knowledge was one of the sources of military power and economic wealth, and hence the support of science was a legitimate federal policy.

The arrangement by which we provided that support now looks hypocritical: we used money appropriated for military purposes to support not only technological development but also basic research by scientists who were really interested only in fundamental knowledge. The scientists who had done such a brilliant job of weapons development during the war argued that our greatest fault had been an overemphasis on immediate practical ends, and a corresponding neglect of basic theory. Congress was willing to accept this argument as long as most of the funds for science could be taken from appropriations for such practical purposes as weapons development.

This was indeed, in a broad political sense, a hypocritical arrangement. But the pattern was a pretty good one, the funds were available, and in fact the universities are still receiving more research and development money from the Defense Department than from the National Science Foundation.

By calling this general set of arrangements hypocritical I do not mean to charge any subterfuge, deceit, or compromise of principles on the part of any individual politician or scientist. It was a good working bargain. But it did depend on the provision of large amounts of money by a government, on behalf of an electorate, both of which collectively failed to understand the distant and uncertain connection between specific research projects and the political purposes that motivated the appropriations acts.

Now this system is played out. The Mansfield amendment expressed some belated congressional distaste for it, and idealistic students and professors denounce military funds as tainted and unfit for scholarly consumption. But the system had four good qualities that I fear may be lost in any transition to a new system.

The first was that it provided money. The military are practical types; they know that fine words butter no parsnips. And just now I do not, in the current political and economic climate, see where the money is going to come from.

The second was that the system was founded on some very practical incentives that discouraged federal officials from interfering in the conduct of the basic research that they financed. When a half-dozen departments and agencies were major contributors to university research, the eminent professor was in a splendid bargaining position. The staff member of the Atomic Energy Commission or the National Science Foundation, for example, liked to have his quota of grants look reputable, so he was eager to deal with top-quality scientists as nearly on their terms as could be managed with propriety, defined as a tremendous degree of freedom in connection with the support of basic research. Moreover, the system of support by project grants, administered with help of advisory panels with members drawn from private institutions, was one that greatly favored the independence of the recipient of funds. (Today, those who want to get rid of military support in favor of greater scientific freedom and more noble social purposes will have to face an awkward fact: the more liberal sources of funds are often the least liberal in their terms of support. Money for research from welfare or educational or housing programs has usually had more strings attached than similar money from the military.)

The third good quality was that the system ignored for most practical purposes the distinction between public and private institutions. Competition is as useful a way to keep up quality in scientific research as in anything else. And the danger we face today is that, in the name of equality, the demand will prevail for making scientific research grants without much regard for quality.

Fourth, our present system did well not to separate basic research too completely or neatly from research for applied purposes. Scientists have lots of ways to disinfect themselves—if they must—from the contamination of funds granted by government agencies interested in practical objectives. And if grants from mission-oriented agencies lead a minority of the scientists who get the grants to take some practical interest in the problems of those agencies, the government will benefit hugely.

Science and Education

Our science policy has been least satisfactory in relation to the general system of higher education. Indeed, it seems to me that the worst thing about our system of research grants has been that it has been used to put off any federal policy for higher education.

As long as we were pumping a lot of money into universities for scientific research, we could duck the difficult problems that are involved in general support of universities—political issues like church-state relations and sticky administrative issues like how to make discriminating choices among universities of widely varying quality.

I do not think that the way out of our difficulties is to support research only in non-academic institutions. The advantage of recognizing, and building on, the union of research and teaching at the graduate level seems to me the point from which our policy should start.

It now seems clear that the nation's stake in higher education is so great that federal policy and federal organization ought to be conceived in ways that will strengthen the university as a whole. While I do not believe the charge that research grants have generally made teaching worse, I think that federal programs have loaded on universities jobs that should have been done by other types of institutions; by giving funds generously for research but not for teaching they have set up temptations that some cannot resist; and by concentrating funds on some disciplines and omitting others they have distorted the program balance of universities that lacked enough resources of their own to even things out among the various scientific disciplines, and between them and the humanities. Worst of all, they have favored certain fashions or trends within disciplines, as the National Science Foundation was forced to do when for several years it could support only those parts of the social sciences that most resembled the natural sciences.

"A new science policy needs to provide for the procedures or institutional arrangements by which science may contribute to policy decisions. Do we need to support new kinds of science—perhaps with more emphasis on the social sciences—and do we need a new and better theory of the relation of science to politics?"

A report of the Daddario Subcommittee proposed to remedy these problems by combining the federal programs for basic research with those for higher education, and by combining programs in the natural sciences with those in the social sciences and humanities. These programs would all be administered by a new agency, the National Institutes of Research and Advanced Studies. While research support should continue to come from agencies concerned with particular operating missions, the National Institutes should provide what is really needed in the way of residual general support. By some such organization or some such procedure the federal government needs to consider these aspects of higher education as a coherent whole, and to realize that they cannot be dealt with in isolation without grave damage.

In education as in research, there are of course real dangers in governmental support: as every state university knows, political interference can damage an educational system. But as the good state universities know, the issue ought not to be one of a fundamental conflict of interest between political responsibility or accountability and educational autonomy. The government, if it is spending its money for higher education, ought to understand that it is in its own interest to spend it in a way that will let it get its money's worth, and not in ways that will degrade the quality of the work it pays for. The effective justification for academic freedom and university independence is not that scholars should have special privileges; it is rather that the types of controls that raise the standards of performance in industrial or administrative work will degrade the standards in scholarship, whether in research or teaching.

I distrust any arrangement that would tie the general support of basic research to any operational program, perhaps in some field of environmental control or urban reconstruction, though it is most desirable to permit every operating agency to support a modicum of basic research. Its administrators are unlikely to be as liberal in permitting freedom to the several fields of basic research as their military predecessors. And such a

tactic would only defer the real problem, which is to persuade the nation that basic research and higher education ought to be kept generally together, and ought to be supported for their own sakes.

Science and Politics

Congress is now quite properly asking how science, if it is to justify its support from public funds, can help government solve the difficult problems that science and technology have helped to produce. At the same time, many scientists are demanding an opportunity to do work on domestic social problems. A new science policy needs to provide for the procedures or institutional arrangements by which science may contribute to policy decisions. Do we need to support new kinds of science—perhaps with more emphasis on the social sciences—and do we need a new and better theory of the relation of science to politics?

Several major studies have been undertaken during the past few years of the social sciences and their relation to government, and their findings go far toward explaining why the social science fraternity was cautious in its response to Senator Harris' invitation to plump for the creation of a National Social Science Foundation.

In crude political terms, the social sciences have always been peculiarly vulnerable to political attack from both flanks. If they undertake to show (and quantify) the sequence of cause-and-effect in public affairs, and thus the relative merits of different decisions, they are accused of undertaking to impose a soulless determinism on the free choice of policies by representative institutions. If they hold back from concrete practical issues, they are ivory-tower theorists who are not worth support from public funds. One criticism fears that the social sciences will determine our value choices; the other scorns them as irrelevant. The physical and biological sciences are equally vulnerable to these attacks intellectually, if not politically.

Science can be protected against such attacks only by an understanding that science cannot determine values or political choices but that science cannot be irrelevant to them—indeed, it cannot fail in the modern world to influence them profoundly. And the understanding must be either general, throughout the public, or in the minds of those with the authority and the incentive to provide support and protection.

In view of the current idealistic hopes that science, and especially social science, may now turn its attention from military to social programs, it may be prudent though disagreeable to reflect upon the advantages to scientists of doing their first large-scale operations research and policy analysis for government within a military framework during a world war. If we fail to understand this point, we are sure to be disappointed as we seek to apply our research to solving problems of environmental pollution, housing, race relations, and all the other knotty issues that plague us today.

The military sponsorship had two great advantages, of which I think only the first is generally appreciated. One was the advantage of a clear-cut objective which automatically overrides all others. Even more than the profit motive of a private corporation, the demand for unconditional victory lets you reduce all issues to questions of means: the ends are not in doubt. Which is to say that in the major military decisions of World War II, politics in the usual sense of the word was was not much of a problem. In contrast, the problem with civilian issues is political choice, and the ends or the values are debatable; only a simpleton can believe that the moral choice is a simple one between degrading the environment by pesticides or smog on the one hand, and on the other producing food, or money to pay for food, for the hungry.

During the second World War, the protection afforded the scientist who worked on military problems was nearly complete; no politician would challenge even the President on a research program. This left the scientists who had been involved in such programs inclined to assume that such independence was natural and to be taken for granted. It was hard for them to recall what earlier generations of natural scientists knew: that the heritage of Jeffersonian attitudes toward science and politics left little room for a status of privileged independence for a research institution using public funds. Indeed, the democratic heritage offered a great temptation to any politician who wished to attack a policy to strike at its most vulnerable point, its research underpinning.

Today, even the natural sciences are vulnerable to political attack (perhaps especially) if they work under military auspices. But there is no doubt that the social sciences are institutionally weaker than the natural sciences, and they need more protection (if they are to make a truly scientific contribution to policy) than our national political habits are likely to concede.

The second advantage that the military enjoyed (and still does) was that it had developed a sophisticated system for relating science to operational decisions. It knew that no problem of warfare could be solved by any abstract science, and that science could be applied usefully only by first converting it into professional skills (such as engineering) and then by applying the professional skills of the technical men to the operational needs or requirements, for which the general officers were responsible. These two steps of translation or conversion had to be taken before science could be used in combat. The third step, political decision by political authority, which during a world war could be taken for granted—was omitted.

This point has been obscured by the glamorous story of the Office for Scientific Research and Development and the Manhattan District, in which civilian scientists challenged or ignored the judgment of military officers and produced weapons of critical importance that the military did not know it wanted. But that experience illustrates, rather than refutes, my point: the scientists who did so knew that they were not acting merely as scientists; they were deliberately going beyond the role of a scientist and encroaching on the function of the engineer, and as they did so they were appealing against

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the operational judgment of subordinate generals to the authority of superior generals—or to the Commander-in-Chief himself.

The civilian agencies of government have done much less to learn how to relate science to policy decisions. The problem there is inherently more difficult, for the first reason I have just noted: there is no agreement on a single overriding objective. Yet we should not give up because the problem is more difficult; science has a great deal to contribute to the analysis and formulation of policy. But we should realize that it can do so only within the context of an organized system of administration which helps translate and combine the abstractions of the several sciences into workable techniques that meet the requirements of clear-cut policies. This is not a job that can be completed by part-time consultants or task forces, no matter how eminent. We have to educate present and future civilian career officers in the ways in which various types of science may be combined systematically to produce operational decisions, and then the departments and agencies have to organize these officials in an effective staff relationship to responsible line authority.

For all the current attacks on science, I suspect that its main danger is that the public and politicians still expect too much of it. We are now tempted to turn to the social sciences for help because we blame the physical sciences for our misuse of technology. But the social sciences are in exactly the same boat; they can be used for bad ends as well as good, and they alone cannot determine our policies or give us the answers. They deal with more difficult problems, and I think need even greater increases in support, than the natural sciences; but they should not be expected in return to give us the answers to knotty problems that can be solved—if at all—only by politics, and only with the help of much more sophisticated and experienced administrative staff than the U.S. government has ever seen fit to permit a civilian department to develop.

It would be easy to yield to pessimism about the prospects of any improvement. Scientists in the leading private institutions (universities and business corporations alike) are suspicious of any change that looks like strengthening the permanent bureaucracy. It is easy to assume the superiority of the outside consultant to the career civil servant. Members of Congress tend to

see the problem in terms of the legislature (representing the people) against the executive (a faceless bureaucracy); it is not easy to persuade the Congress that only a competent and disciplined administration can define the issues in terms that will enable elected political authority to assert the general interest over the strong forces of specialized technology. And the apparent leaders of the student generation want science to be relevant, but they also hate bureaucracy; it will take some time for them to learn that knowledge can be made relevant only within the framework of disciplined and responsible institutions.

A Perpetual Crossroads

Yet there has been a pervasive intellectual revolution—of which the student violence has been only the most conspicuous fringe—which has led conservatives and radicals alike to question the assumptions on which our science policy was founded immediately after World War II.

Those assumptions were, fundamentally, that scientific and technological advancement is a means of automatic progress, and that our existing political and administrative institutions are adequate to deal with any problems that it produces.

Once those assumptions are discarded, we must choose which way to go; we do not have the option of standing still.

One doctrinaire way would reject reason as the desirable criterion of political choice. This would undertake to solve our problems by suppressing science and technology, destroying the autonomy of universities and scientific institutions, and rejecting the authority of responsible government. The danger, of course, is not immediately from the few theorists who would accept such absolute measures but from the practical politicians who would indignantly denounce them and then—infected with the same mood—take minor practical steps in the same direction, to put unpopular eggheads in their place.

The other way would be to find means to support free and autonomous science but at the same time to control its technological results in the public interest.

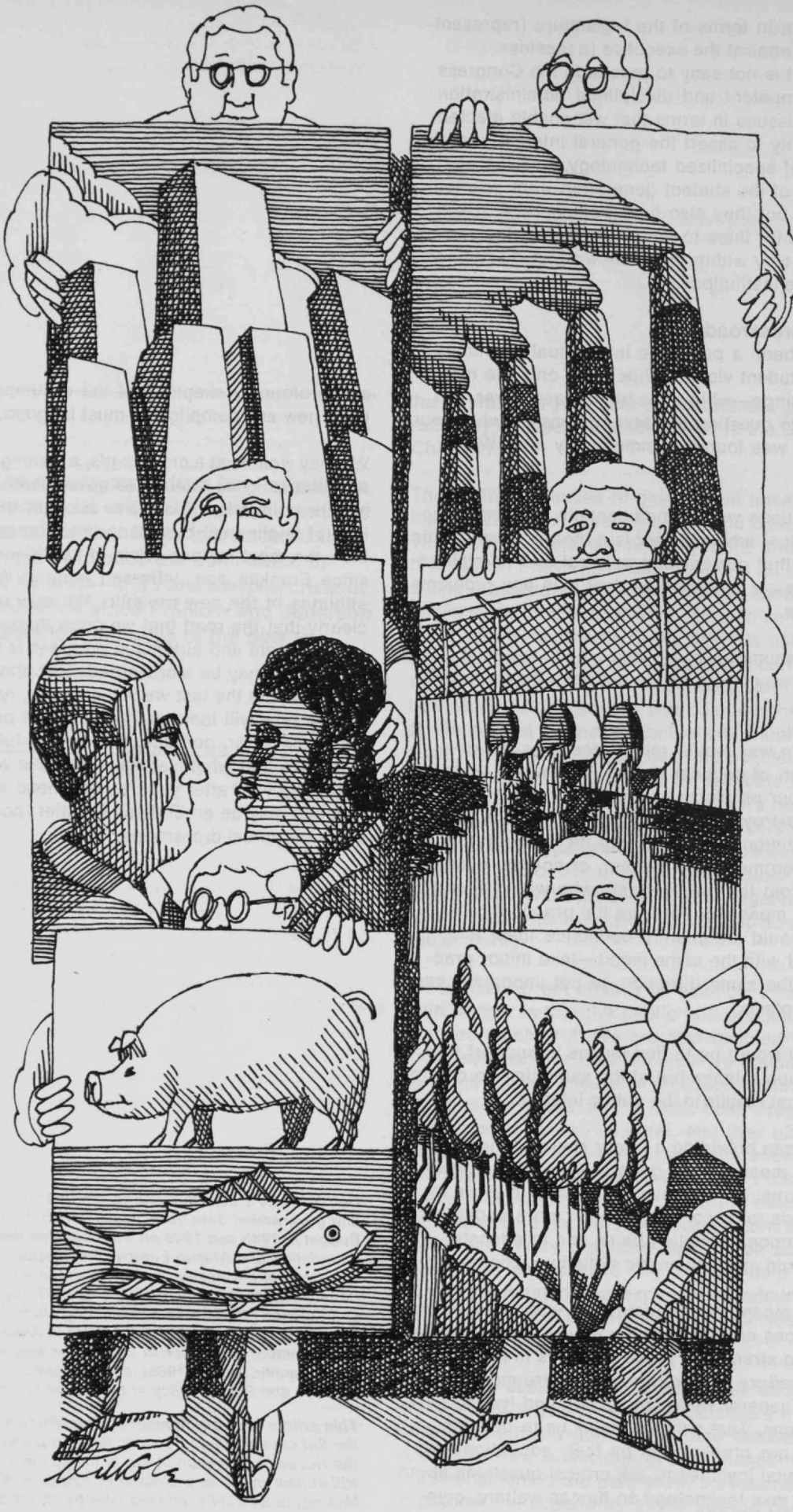
This would mean providing a larger share of the support of science by means of the general support of educational institutions; it would also emphasize in those institutions efforts to discover and teach more about the relation of science to public affairs, and to educate those who would apply scientific skills to public policy.

It would also mean understanding the way in which science alone does not settle policy issues, and therefore undertaking to strengthen those elements in the structure and procedure of government that are more committed to the general values of society and less to particular programs. That would require us to develop officials who are predisposed by their education and their institutional loyalties to ask critical questions about the effects of new technology on human welfare, competent to use science to help assess new developments, and profoundly skeptical of the assumption that anything new and complicated must be good.

We may well be at a crossroads, a turning point in policy, for science in its relation to government. For we must have a policy that takes into account the contemporary loss of intellectual confidence in science and its benefits—the most serious crisis of confidence in America since Franklin and Jefferson molded the intellectual attitudes of the new republic. We may as well see clearly that the road that we once thought would lead to permanent and automatic progress is now a dead end. There may be a crossroads just ahead, but we need not think it is the last we will come to, or that a wrong choice now will land us in permanent perdition. It would be safer, perhaps, to be cheerfully pessimistic—to realize that whatever route we take will need to be corrected year after year, as far ahead as we can see. Science may be an Endless Frontier; politics is more like a perpetual crossroads.

Don K. Price's contributions to the interrelationships of science and government date from his service in the U.S. Bureau of the Budget in 1945 and 1946 on what became the National Science Foundation and Atomic Energy Commission; he was Deputy Chairman of the Research and Development Board of the Department of Defense in 1952 and 1953; his book, Government and Science *(1954), was a pioneering study of the relationship; he was President of the American Association for the Advancement of Science in 1967. He is also the author of* The Scientific Estate *(1965), and he conducts a seminar on Science and Public Policy at the Kennedy School.*

This article is an abridgment of Dean Price's testimony before the Subcommittee on Science, Research and Development of the House of Representatives in the summer of 1970, which will appear in full as a chapter in American Politics and Policy Making, *to be published next year by Winthrop Publishers, Inc., of Cambridge.*



No one denies our need for better understanding of our technological and social alternatives and their future effects. Here is an eloquent argument for one way to achieve at least a part of that ultimate wisdom

David J. Rose
Director for Long-Range Planning
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The Case for National Environmental Laboratories

Few will dispute that we must live with grace, with dignity, with style, and with social justice. But the words mean different things to different people; and the aims seem strangely unfulfilled, sometimes perversely frustrated by our very attempts to achieve them. Everyone points to pollution, to sources of it, and to others for having limited his options: a recreation area gone, a too-early disability, a total urban environment that seems a caricature of technology. We believe that these difficulties are (in part) attributable to a lack of organization, which is correctable within the broad framework of our society.

In briefest abstract, in this article we develop the idea of organizing certain institutions more meaningfully to match science and technology to the national environmental and technological assessment problems that we face. The organizations envisaged—National Environmental Laboratories—would have interacting components from many physical and social sciences. By their structure and method of working, they would be able to cut across the fabric of environmental problems, in directions not hitherto possible.

We reject any Luddite philosophy, accepting a more optimistic one. As the recent report of the National Academy of Sciences Panel on Technology Assessment puts it, we have a new chance, because "our visions and capacities have so broadened and deepened that we can now, for the first time in human history, realistically aspire to have it both ways: to maximize our gains while minimizing our losses . . ."

To reach a workable scheme for implementing such extravagant hopes, we find necessary a very broad view of our affairs; no lesser one seems to fit. The environment is that of people as well as of the wilderness, and social as well as physical; we will find business both in the city and in the country. Solving present environmental problems is a retrospective task related to past mistakes, and difficult enough as all can see. But difficult in a different way and inseparably joined is the prospective task of arranging our future in ways least likely to cause uninvited trouble. We have thus two outlooks, as the two faces of Janus, one showing foresight, the other retrospective correction. If the title truly must describe the function, we should propose establishing *National Environmental and Technological Assessment Laboratories;* but we eschew the gaucherie.

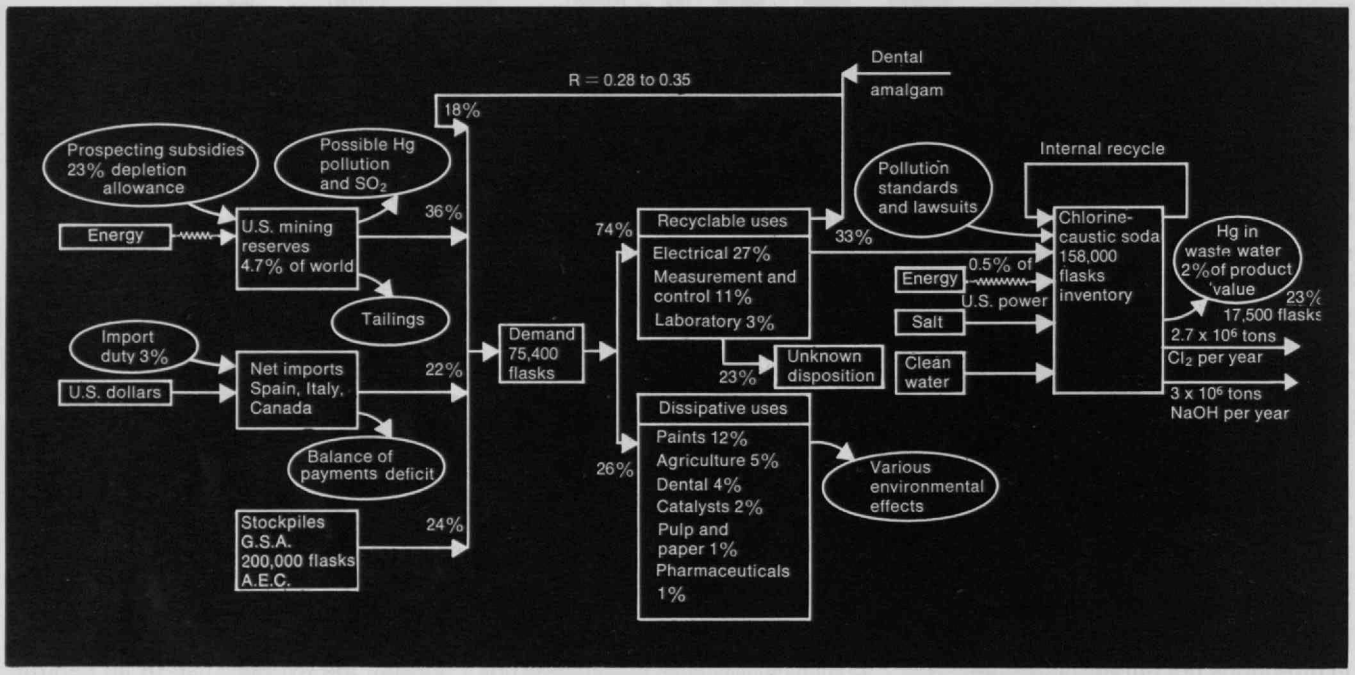
To see this ubiquity, consider the ramifications of just one problem: central station power for the future. We all surely agree that it cannot be resolved without evaluating possibilities for nuclear and fossil fuel devices. Thus conventional power engineers, nuclear reactor engineers, heat transfer specialists, and so forth are needed. Full resolution also requires consideration of how the waste heat (in the most modern plants still a larger amount of energy than all the electricity generated) is to be disposed of. Hence comes a requirement for experts on water and air resources. This might seem to make a tidy package, but the problem size hasn't yet appeared. Perhaps the reader imagines us about to include the indirect and direct costs of strip mining for coal, or radioactive effluents from nuclear fuel reprocessing plants, or long-distance power transmission costs (which help determine whether to put the power plants near or far). And so they are included, making the true scale of the problem much broader than before. Perhaps this is enough?

Not so; reflect upon what follows. Power economists in England point out that the average use of all central station plants in the U.K. is about 50 per cent (because of reserve capacity for peak loads, old units saved for emergencies, etc.). But in London the average use is about 33 per cent, because of high workday demand and low demand at all other times. Old power plant sites in London are small. An economic study made on this basis would indicate a future requirement for small, low-capital-cost (per unit of power) plants. Fuel cost would be secondarily important.

Perhaps this is the correct solution, but maybe it is totally wrong. Land is cheap for a power plant compared to the plant cost itself, even in London. What about the alternate scheme of a few very large plants with low fuel and operating cost? Off-peak power could be made very cheap—perhaps free to some classes of users and attractively cheap to others. That kind of power policy could be used to stimulate an entirely different approach to the inner city problem of London.

Beside all that, the power problem is more than electricity. The principal energy requirement is for heat, specifically, and not electricity—even for some time into the future, and even apart from transportation uses. To satisfy that demand by nuclear energy would mean installing nuclear reactors in cities, which adds more

The flow of mercury into and through U.S. society was traced in one Oak Ridge study. The figures are percentages of total U.S. demand, and relate to 1968.



dimensions to the discussion. And where was included a host of purely sociological factors—for example, the very real one that some communities just will not permit the power plant to be built inside their boundaries, irrespective of all arguments?

Then what is the policy to be? We face the future with less certainty than before. It is in all these issues together and not in each separately that the true scale of problems appears—problems which are born whole and flourish throughout society. Subdividing them at intermediate levels—into "power plants" or "urban planning" or "heat disposal"—is necessary to assign specific tasks as meaningfully as possible. Thus the need exists and will continue to exist for organizations like the Water and Air Quality Offices of the Environmental Protection Agency (E.P.A.), Federal Power Commission, and so on. But it is the contention of this article that even though special agencies work competently (and sometimes brilliantly), the fragmentation of present approaches makes the effort inadequate because no one considers the whole system. We are in danger of comforting ourselves falsely while undetected layers of problems become even more intractable.

Many of these ideas, and the need for new capabilities, have been expressed before. Senator Edmund S. Muskie's Subcommittee held two years of hearings. Former Representative Emilio Q. Daddario called for increased utilization of national laboratories. The American Chemical Society has made a detailed study of needed environmental tasks. Both the National Academies of Science and of Engineering (N.A.S, N.A.E.) in 1969 published eloquent treatises on technology assessment, which is the prospective view of environmental preservation, and which unfortunately receives scant popular attention compared with repair of past mistakes; but surely one makes little sense without the other. Because the forward directions are unclear, technology assessment must be broad and may be the more expensive operation. Exploring several methods of developing nuclear power is in part an exercise in technology assessment; not all schemes will be put into service. As another example, a 300,000-ton oil tanker as presently constructed, operated, and regulated may be a greater hazard than all its beneficial economies permit; judging what should be done is part of technology assessment.

For many of these problems, retrospective correction or prospective adjustments may be indicated, but no adequate mechanism exists to detect problems in a sys-

tematic way at early stages of development or deployment. Indeed, what is an "early stage"? Timely consideration must be given to potentially injurious effects, often upon sectors of society and the environment quite remote from the initiating places. For by the time deleterious consequences have become obvious enough to generate public concern, we may find that the commitments of various groups to technological paths and institutional arrangements will have made correction very costly.

A second difficulty with the present approach relates a little to the previous topic, but stands by itself: self-interest. Even clear vision of future effects does not alone suffice, if the warnings of potential injury fall on senses dulled by selective interest in exploitation of the technology. This is no accusation of common venality, as the N.A.S. Panel remarks: "With few exceptions, the central question asked of a technology is what it would do (or is doing) to the economic or institutional interests of those who are deciding whether or how to exploit it."

Missions and Some Constraints

The missions and methods of working of the proposed National Environmental Laboratories (N.E.L.'s) can be described in a number of ways. Most broadly speaking, the program of N.E.L.'s will comprise developing and presenting to decision makers ordered sets of alternates for problems affecting the existing or future environment, whose costs and benefits—both economic and social—are clearly defined, and making sure that all sectors in the nation can be aware of available options; but, as an important exclusion, the Laboratories would have no decision-making or regulatory functions.

Regarding the first part of this program, we take a position contra those who suggest that scientists must present in clinical sterility only the data, from which the decisions can then be deduced or inferred by policy makers. If the "sterile data" concept had worked, we wouldn't be facing so many environmental problems today. Regarding the second, we feel that lack of information and communication are correctable faults in our present society; indeed, there is sore need of correction, in a very fundamental sense. Because the N.E.L.'s must interact across many government departments and agencies, assigning them executive power would be both undesirable and unacceptable.

Next, two broad working principles can be stated thus:

◊ Reintegration at both the working and advisory levels of all the disparate parts of these national problems. It is this synergism and the methods to achieve it that permit the new approaches, the cuts in new directions across the fabric.

◊ Maximizing the mobility of relevant information and of ideas. Detailed actions will derive from these considerations: in-depth analysis of environmental problems, information accumulation, applicable basic research, evaluation, technological development, systems analysis and assessment; studies of biological, ecological, and sociological effects; communication of all kinds; and cooperation with many other public and private agencies. Much more could be added.

A number of other features must be recognized, in addition to breadth and past-future aspects.

Most important environmental problems are not properly definable in terms of single specific tasks or even as a sum of such separate tasks. This basic point influences our whole approach. In early times, when man's relations with his fellows and with the environment were so weak that the environment appeared as an infinite resource, each activity was generally describable separately; separate cures—for a dirty stream, for instance—could meaningfully be prepared. The optimum solution consisted of optimizing each part independently. Today our activities have grown until the environment appears finite in comparison; the relations are coupled, a situation that generates conditions and solutions of quite different character. Very importantly, optimizing the whole system is by no means approachable by any process of optimizing each segment individually. As a simple example, optimizing pulp and paper manufacture exacerbates water pollution. Charges and costs that are inadvertently (and sometimes advertently) put upon us all by this process of too narrow optimization are called external diseconomies, which significantly were unrecognized in economic theory until fairly recently. In the paper manufacture example above, polluted waste water dumped into a river without being cleaned represents an external diseconomy. Throw-away beer bottles and automobile graveyards are others.

Each problem's interdisciplinary complexity impedes both problem recognition and a will to commitment by those in specific technical fields who might have offered imaginative solutions. The fact that any effective solution or abatement procedure changes the environmental problem that was being studied bespeaks a degree of coupling often found scientifically uncomfortable.

The tasks of technological abatement (of present problems) or technological assessment (of future ones) have large technological components, which might sound like a tautology; but there is a point yet to be emphasized: We believe that these environmental tasks, both retrospective and prospective, must proceed in the synergistic atmosphere of large working laboratories and not just in "think tanks." It is all too easy to lose sight of alternates, to assume that solutions exist where they do not, or to miss exploitable developments.

To achieve their tasks, N.E.L.'s will contain contingents of social scientists—especially resource economists and demographers, but also lawyers, political scientists, social psychologists, and so forth. By interactions among such persons, natural scientists, and engineers, we hope to analyze systems broadly enough even to include some measure of aesthetic value, which enters at least *sotto voce* into decision making.

Some Characteristics and Functions

Let us see more specifically what N.E.L.'s might look like. We have in mind several—perhaps five or six—throughout the country, each containing several thousand persons. This size and extensiveness (not only inside institutional buildings but also working outside in the environment) are necessary, in our opinion, to be effective. Some N.E.L.'s would have particular expertise in specific areas—urban problems or resource management, for example—but all would be closely knit and all would share common capabilities. A system comprising such large organizations would not fit well as an adjunct either to the President's Executive Office or to the Congress; yet N.E.L.'s must be closely connected to these places. A separate commission (or equivalently named organization) reporting jointly to both branches seems to us most appropriate.

Regarding start-up, there appears (fortunately) no necessity for N.E.L.'s to start full-grown, as Minerva from the head of Jove. It is the totality of tasks and other things that makes for large size, as much as the size of many of the environmental tasks themselves. Thus, we can imagine smooth and mostly internal adjustments whereby environmental functions are grafted onto existing organizations. By way of example, the Argonne National Laboratory established in December, 1969, an Environmental Center to focus on a number of its related activities; the Oak Ridge National Laboratory has for some time been directing about 10 per cent of its effort (about $10 million per year) to environmental problems of many kinds, as integral parts of its program which is now expanding considerably under N.S.F. sponsorship.

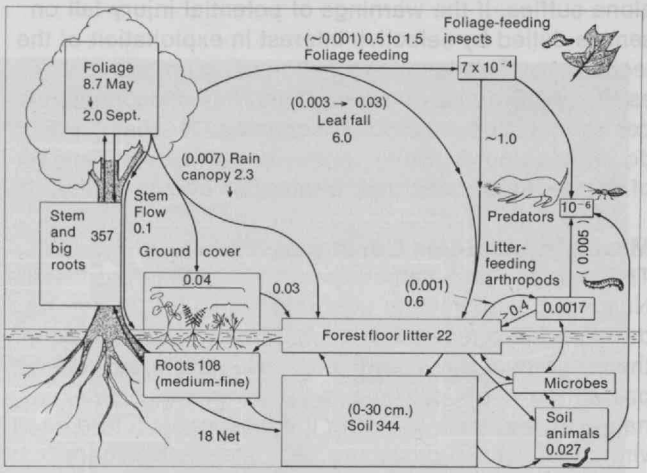
One thing seems clear: it must be agreed upon at the start that N.E.L.'s must have very considerable discretionary power in arranging their own programs. Almost by axiom, no one elsewhere will see the whole scope a priori. On a more general note, too rigid control never works well for such tasks anyway: if the qualities of the controlees is such that the control is needed, the wrong people have been put on the job and nothing much will be created. If the putative controlees have the qualities most needed in an N.E.L., they are the best ones to assume important programmatic roles. In effect, choosing the team establishes de facto the trust. This arrangement calls for persons of outstanding quality, without whom the whole idea fails.

Operating Procedures: Five Activities

In looking inside N.E.L.'s we consider that their method of working is more important than any specific organization chart. Five activities, all interrelated, stand out.

The first of these is *programmatic perception,* basically

A forest ecosystem—that of Liriodendron tuliperifera*—traced with a radioisotope, cesium-137. Initially the trees were tagged with 467 μc of the isotope (934 μc per square meter of ground area). The numbers in the boxes are in microcuries per square meter ground area, as measured three years later. Arrows indicate transfer routes, with estimated annual flux and (in parentheses) daily flux during seasons of activity.*



the answer to such questions as, "Where is the laboratory headed?" and "Is this the right direction?" With the imagined internal population, and the need for continual reassessment of missions and objectives, we see the need for laboratory-wide guidance and judgment. This is no new thing: the most creative research laboratories and universities (and government itself) operate internally as participatory democracies, at least sometimes.

The second activity is *information gathering and processing.* This is the scientific sensing part of the N.E.L. It must be able to measure things, as we have said: such things as transport of nutrients into and out of forests, learning in advance what it really would mean to apply fertilizers widely in silviculture, or the effect of new transportation technology on commuting habits. We see many disciplines involved—not just in monitoring but in predicting, testing predictions, and so forth.

The largest information-gathering function of an N.E.L. is not its own measurement program, however; an N.E.L. could aspire to do only some of the measuring. It would arrange to have interactive access to activities proceeding elsewhere, leading to a much-needed coordination. This is made possible by the technologies now available for obtaining, storing, correlating, recognizing, and retrieving information. There is thus both a measuring (and diagnostic) function, and a broader, information-handling function.

Third comes *systems analysis,* the modeling and assessing of what is to be expected as a result of what action. This increasingly powerful art has already been

applied to economic analysis of reactor systems, urban planning, and so forth. Notice again the emphasis on computers and information-processing techniques.

Next is *research and development* in its fairly classic sense. Here we find little difficulty in understanding and appreciating either the role or the necessity for it, and we differ only from those who propose to operate in "think tanks" remote from the real benchwork or hardware development.

The research and development requirement is sometimes small, sometimes large. It connects with the social sciences—e.g., quantification of aesthetic values—which is a new thing for laboratories of the sort we have in mind. Not all research and development is performed in-house, of course; each N.E.L. should know the nation's shopping list relevant to environmental problems and buy important items itself from time to time. Here the concept must be recognized of developing systems to a stage of assessability, whereupon some may be dropped. This winnowing, even on the scale here proposed, is well understood in both public and private industrial sectors.

Fifth and finally is *communication,* perhaps the most important of all—and one often ignored or misunderstood. Maximizing the mobility of ideas is a guiding principle behind our plan.

A continuing public dialogue is required for many purposes: to make people aware of developing technologies and their effects and to provide for independent criticism and countervailing pressures—potentially a powerful balance on the activities of an N.E.L. Among the mechanisms to stimulate these interchanges are:

◇ Public reports and annual national reports.
◇ A determined policy of no security classification or privileged documents.
◇ Open hearings where any activity can be questioned.
◇ Public lectures.
◇ Substantial personnel interchange programs among N.E.L.'s internally and between N.E.L.'s and industry, universities, and other organizations.
◇ An aggressive policy of transferring technology to the public sector through public communication, attitudes that encourage spin-off, and so forth, in addition to the traditional professional methods.
◇ A function (or section) concerned with advising the Congress and the federal executive branch, and state and other organizations, of major possibilities and developments and with responding constructively to requests. To put it colloquially (but importantly), there should be a number that a congressman can call; and to any reasonable question he should expect an answer.
◇ An active international program of exchanging information and personnel.

These communication functions serve many roles besides the most obvious ones of transferring information. They protect the public from N.E.L.'s becoming irrelevant or dictatorial; they infuse the N.E.L.'s with new ideas and vigor from students; they serve to motivate industry to search within for its own technical solutions as well as to interact with others.

Some N.E.L. Tasks: Energy and Transportation

What will an N.E.L. *do*? We have had no difficulty finding more than enough tasks to start on, and the experience gained will suggest much more.

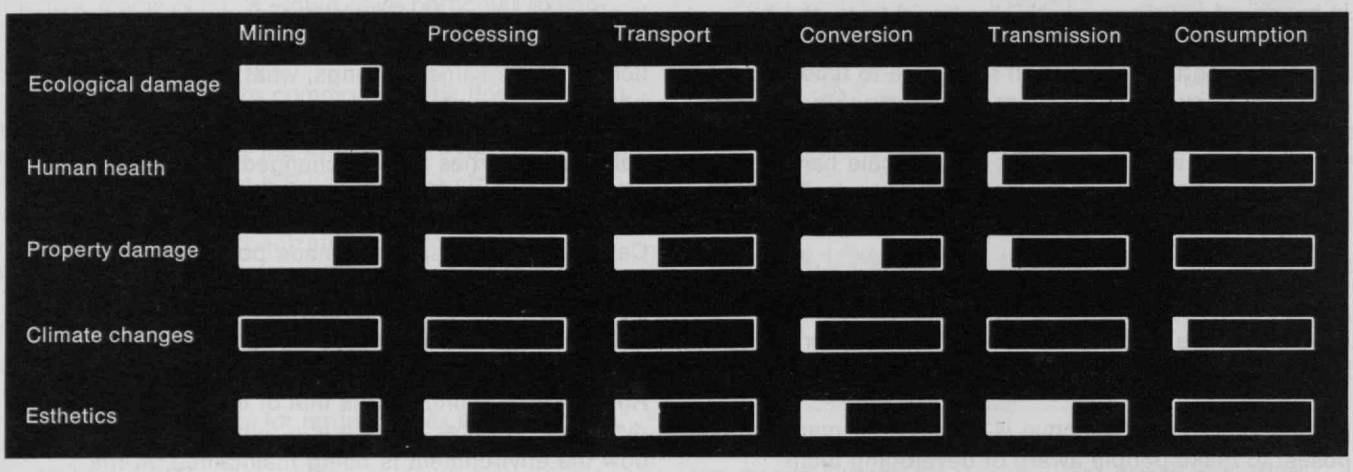
The central station power problem already mentioned exists in its own right, but an extension into the whole question of energy is more important and seems ripe for meaningful work. Some 70 to 80 per cent of atmospheric quality degradation arises as a result of energy transformation, depending on how the terms are defined. Providing large amounts of power at lowest total social cost is only one part of this larger problem. How it is used is also important. Making better insulated buildings requires energy, and so does the heating and air conditioning of the same buildings; what should the trade-off be? The average temperature of earth will not rise even if energy use is increased many-fold (assuming atmospheric properties are not changed thereby), but local effects can be severe: should city planning include attention to some principle of minimum entropy increase? Can personal transport be made pollutionless in truth, by development of hydrogenic fuels in safe carriers, for instance? Some attention has been given to these matters, but not in the integrated way here envisaged.

Another compelling idea is that of environmental "indices" or "profiles." There is a public need to know how the environment is being maintained, in the simplest meaningful ways, and indices should be developed applicable to air, water, land, etc. This would permit not only the comparison of degrees of pollution among different areas but also the charting of changes in the pollution of a specific location. For example, the index could show that a certain harbor has the lowest (worst) index in the U.S., or that a measured improvement has occurred as a result of enforcement of new regulations regarding waste disposal along rivers that empty into it.

Parenthetically, consider the results of actually setting up N.E.L.'s in the absence of indices. A large amount of money is appropriated. A multiplicity of programs begins—but it is hard to see if anything is happening, partly because of the nature of slow changes. Even a successful program might then be jeopardized. With widely understood and respected indices, however, the problems and approaches come directly into focus, and merit can be measured in real terms.

This environmental-profiles question shows a property common to many of these diffuse environmental tasks: the difference between scientific and sociological motivation. Even now, the Water Quality Office of the E.P.A. provides much information on water quality, and also other agencies, *mutatis mutandis;* thought has already been given of how to develop useful profiles, and the more the thought, the more slippery scientifically the idea seems. On the other hand, political and regulatory decisions on environmental matters are made, and these decisions have substantial binary character; so the need exists, filled at present by

The "external costs" associated with the production and consumption of electricity, according to a recent Oak Ridge study, can be broken down into this matrix of categories. In each box, the white bar indicates the estimated magnitude of the effect.



confused intellectual processes of sorting, acceptance, and rejection of factors. It is hard to imagine that we could not do much better.

Topics can be large or small. Lead pollution from auto exhausts is a topic small enough and simple enough for all its main parts to be set down here. Leaded gasoline leaves deposits inside automotive engines which cause increased emission of unburned fuel; that exacerbates the smog problem. Also, large amounts of fine particulate lead compounds in the environment are a hazard whose importance is just now coming to be appreciated.

Lead-free premium fuel can be made at an additional cost of two or three cents per gallon. Switching formulas gradually would not particularly bother either the large petroleum refiners or the automobile manufacturers. If that were the whole story, we might decide to switch, not even bothering to assess in detail any further the leaded gasoline hazard: the fix is cheap. But there is more to the story. The additional aromatic hydrocarbons put into lead-free gasoline tend to exacerbate the smog problem and appear to be more hazardous to health than the other constituents. Thus, we define several interacting aspects:

◇ The hazards of continuing lead pollution.
◇ The hazards of aromatic hydrocarbons to gasoline handlers and, at low levels, to the public.
◇ The penalty (if any) of having engines use lower octane fuel.
◇ The probability of entirely new engines becoming available, using different fuel.
◇ Automotive emission control, including the possibility of requiring catalytic systems, and taking into account the fact that such control can be more effective in clean (lead-free) exhausts.
◇ The need to conserve lead, whose ore reserves are rapidly diminishing.

The problem is not yet resolved, but it can be defined in terms of real tasks. In the last year, it has also been taken up seriously and more publicly by auto manufacturers and petroleum companies.

An important responsibility of an N.E.L. would be to develop biological assays that allow us to make a reasonable estimate of how hazardous a given insecticide, herbicide, food additive, etc., is for man and others. At present there is an incomplete arsenal of suitable tests, and they are somewhat haphazardly applied. One of the most striking weaknesses of current tests is that they are primarily geared to measuring immediate effects on the organism exposed to the agent; they provide inadequate estimates of genetic effects or long-term environmental effects that will be revealed only much later. It is important to develop surrogate long-term tests that can be applied rapidly and routinely to agents that are being considered for widespread introduction into the biosphere. The counter argument that with such a policy, DDT would never have been introduced (or the first automobile ever run, etc.) is specious: with a properly balanced arrangement there comes timelier warning, which is benefit enough for now.

Note that many of these activities would proceed partly inside, partly outside an N.E.L. Any or all could be presently undertaken at least in significant part by some present laboratories, if their missions were so defined.

These phrases reintroduce the question of how N.E.L.'s can be started, and we offer a further thought. Physical and social scientists have contributed their joint skills and feelings to a number of real problems—such as urban decentralization—at the Oak Ridge National Laboratory. The experience has been excellent for all; the very act of interacting showed new and valuable directions to move. Therefore, we have come to believe that the interdisciplinary art, science, and spirit for which we aspire will indeed flourish in a budding N.E.L. structure. Then in a little while that group itself will tell us important things about our concepts. These are matters of belief, faith in an idea, and social purpose; we have no absolute answers. The concepts need some physical expression and practical working to be made more sure.

A Dismal Future? Or a Careful One?

These ideas about N.E.L.'s raise a number of questions larger than details of organization or of specific tasks.

To some it may seem that we propose just one more way to organize ourselves, to limit our freedom, to impose more government, to interfere in each other's business, to heap contumely upon the bureaucratically disadvantaged. Some of these are distortions of real intents (to organize better), some are real dangers—especially the last ones mentioned. About the organization: if we demand the fruits of an ever-more-complicated technology, we must be prepared to accept the necessary degree of coordination as well. About the dangers: we have tried to arrange some checks and balances. But in this as in all things a charitable nature will help greatly.

Others have described our problems in different terms, a fact which we have noted earlier. A recent series of papers deserves further comment. In the first, Garrett Hardin in *Science (162*, pp. 1243-48) treats expansively what he calls "The Tragedy of the Commons." The title alludes to the pitiful disaster that befalls herdsmen who graze increasingly more animals on a finite common pasture; each sees one animal profit per animal added by him; the cost being borne by all, his share of it small; so everyone adds animals and the common resource fails. Hardin generalizes the idea to cover our misuse of total resources. This is another graphic account of the lugubrious importance of external diseconomies and of nonlinear interactions between us and the environment. Regarding what to do, we share some of Hardin's intents to internalize the costs, sometimes by regulation, sometimes by relatively straightforward technological development. We and Hardin speak also of urgency, and public recognition of importance. In the end, he advocates schemes of mutual coercion and eschews much appeal to higher morality.

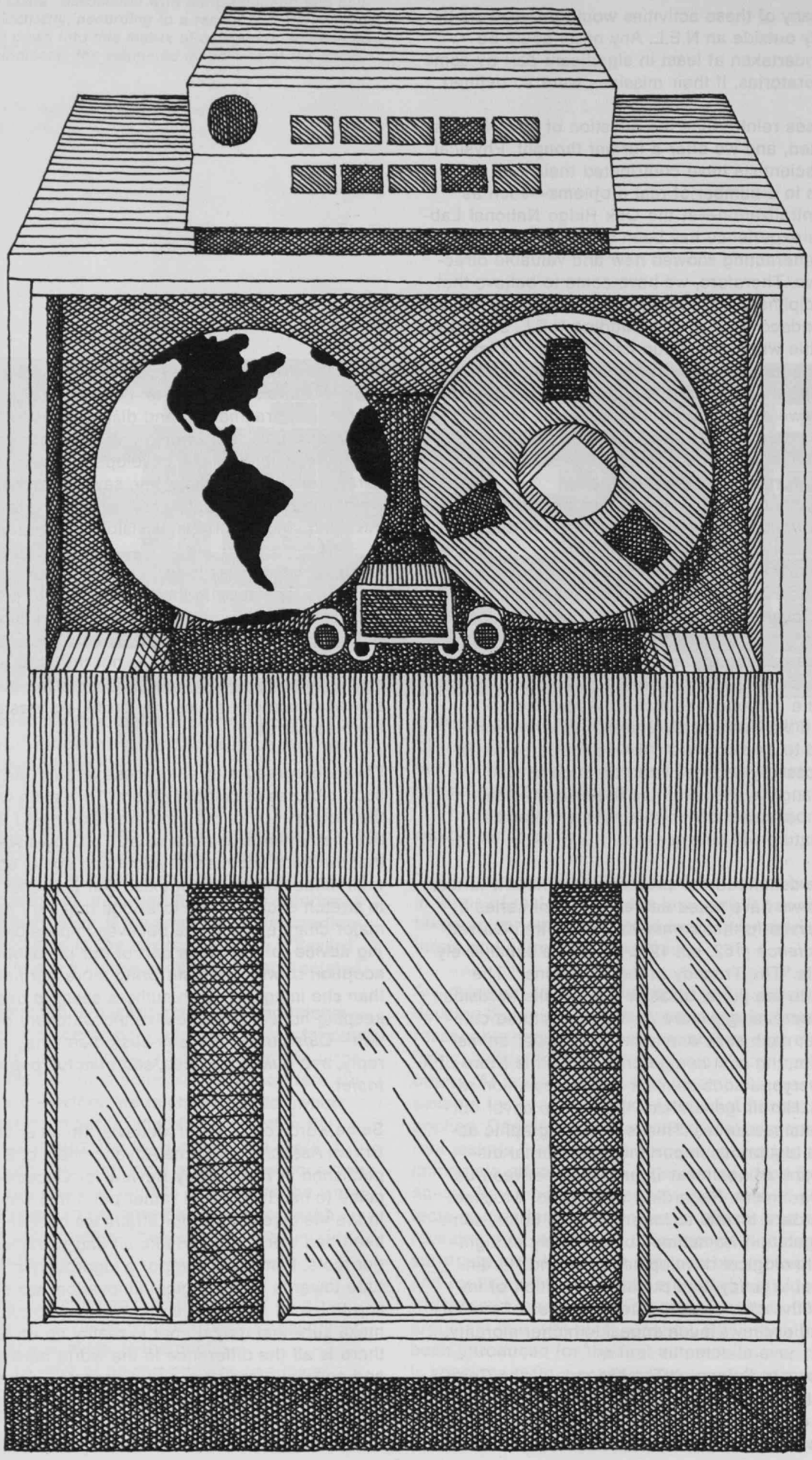
Beryl L. Crowe in *Science* ("The Tragedy of the Commons Revisited," *166*, pp. 1103-07) pushes these ideas further and correctly opines that the social and physical sciences have gaps between them, into which have fallen the great insoluble (sic) problems. She denies the utility of mutual coercion, on grounds that society has become too fragmented and disputatious to find common motivation, upon which any workable coercion (i.e., persuasion) can be developed. Nevertheless, temporary relief could follow, she says, if science played a much more constructive role in correcting diseconomies and keeping problems visible to the public eye.

A third related essay is Dr. W. G. Pollard's "Moral Imperatives for Peace in the Remainder of This Century." Our resources now disappear at an alarming rate, he points out; the end is in sight. Then what must determine our moral imperatives is not threat of war, not the clash of economic systems, but scarcity—the inexorable advent of scarcity caused by profligate waste of common resources.

We have agreed with all of these in part, but paint no such pictures of colorful gloom. To Hardin we suggest that recognition of the problems exists and that effective instrumentalities can exist. To Crowe we point out that the gaps between physical and social sciences are man-made and need not exist. Our proposal attempts to stretch each science to bridge that very gap: the very major change which she believes impossible. Her parting advice to science is part of our philosophy, the adoption of which should bring more permanent relief than she imagines. Both authors seem to despair of keeping honest and effective the watchers of our condition—*Quis custodiet ipsos custodies?* they ask. We reply, *nec quisquam unus, sed cunctus populus custodiet.*

Some words of Sir Peter Medawar (in an address to the British Association for the Advancement of Science, published in *Technology Review* for December, 1969) come to mind: "I would rather put it this way: that in the management of our affairs we have too often been bad workmen, and like all bad workmen we blame our tools. I am all in favor of a vigorously critical attitude towards technological innovation: we should scrutinize all attempts to improve our condition and make sure that they do not in reality do us harm; but there is all the difference in the world between informed and energetic criticism and a drooping despondency that offers no remedy for the abuses it bewails."

To Pollard we join in the necessary belief that sufficient



public morality does exist or at least can be grown. Otherwise Crowe's dismal future really lies ahead. But we disagree that the moral imperatives must relate to scarcity—too many good alternatives exist. They should better pertain to more thoughtful organization.

At a more spiritual level, we find such arguments as have been made by Lynn White Jr.: our Western Judeo-Christian heritage has led us to subdue and rule the world (Genesis 1:26), hence brought us to an ecologic crisis. More appealing and equally derivable is the view that man should revere what God has created; this is the only Kingdom of God of which we surely know.

History brings us a number of examples of environmental problems, both foresight and hindsight, both good and bad. If the Romans had known about lead poisoning, would they have built their plumbing system as they did? Quite possibly not, for their planning and building of aqueducts and roads, draining of marshes, and development of concrete bespeak concern for the well-being both of themselves and of their environment. Janus was a Roman god, not a Greek one.

Singer, Holmyard, Hall, and Williams' excellent *A History of Technology* gives us some interesting historical examples. Making of charcoal for iron smelting was a strong contributing reason for the deforestation of much of the Mediterranean lands in classical times; and so the region remains to the present day. The continuing need for wood led to transfer of the iron industry and of technical dominance to Germany.

The horse collar is an interesting item, where ancient technology assessment profoundly affected the social structure. In Roman times it was well known that a horse was basically a higher-output and more adaptable work-animal than an ox. But yoking a horse as an ox tends to choke it, and the ancients knew no better. Under those conditions, a horse could do four times as much work as a man, but it ate four times as much; so horsepower and manpower were at a standoff, and the Romans had no rapid road transport. Many inventions were tried for several hundred years; finally the horse collar (used in China about A.D. 300) was adopted in Europe about A.D. 900. Thereafter Europe enjoyed more rapid road transport and slavery declined as a raw power source.

In earlier parts we spoke of unbalance appearing accidentally in the words and in the apparent intent—the examples were characteristic, but of what? The social scientist says that problems range from technological A to social Z, and we have gone from A to B, not far enough. A danger of qualitative misunderstanding then arises, of our seeming to propose solutions as if we understood how science, technology, society, and the environment all interacted. In truth, none of us understands very well how the system works, which may be as good a capsule description of our difficulties as any. But we believe that by joining social and natural sciences, technology, and new ways of thinking about large problems, we will make much progress. After all, the gamut of successfully attacked problems really only runs from A to A′ as yet, and there is plenty of room for improvement.

A nice balance must be struck between conservationist-environmental and technological assessment outlooks in an N.E.L., as we said at the very beginning. In oversimplification, one view tends to suppress technology, the other to promote it. To achieve the balance, we join these concepts in one organization, hoping to produce a most reasonable view. The N.A.S. panel attempts to achieve the same objective by putting technology assessment in an expanded Office of Science and Technology. Our plan is different, but not all that different—a renamed and enlarged O.S.T. would resemble some of the N.E.L. structure in many ways. Some of the needed tasks are being taken up by the National Science Foundation. The N.S.F. allocated just $6 million in 1969-70 for this kind of activity; the 1971-72 projected budget for its RANN program (Research Applied to National Needs) is $81 million.

Are we preaching a counsel of unattainable perfection? Not this side of Paradise, not unless we are foolish, unable to see or accept improvement as a guiding principle. If we know the goal and see plainly only the first step toward it, then let us take that step: the next will be clearer from the new place. There will even be mistakes along the way, wrong alternatives sometimes proposed, wrong decisions taken as a consequence. But with better instrumentalities our mistakes will be fewer, wherein is the benefit. It is the making things better than hitherto that we try to bring about.

Suggested Readings

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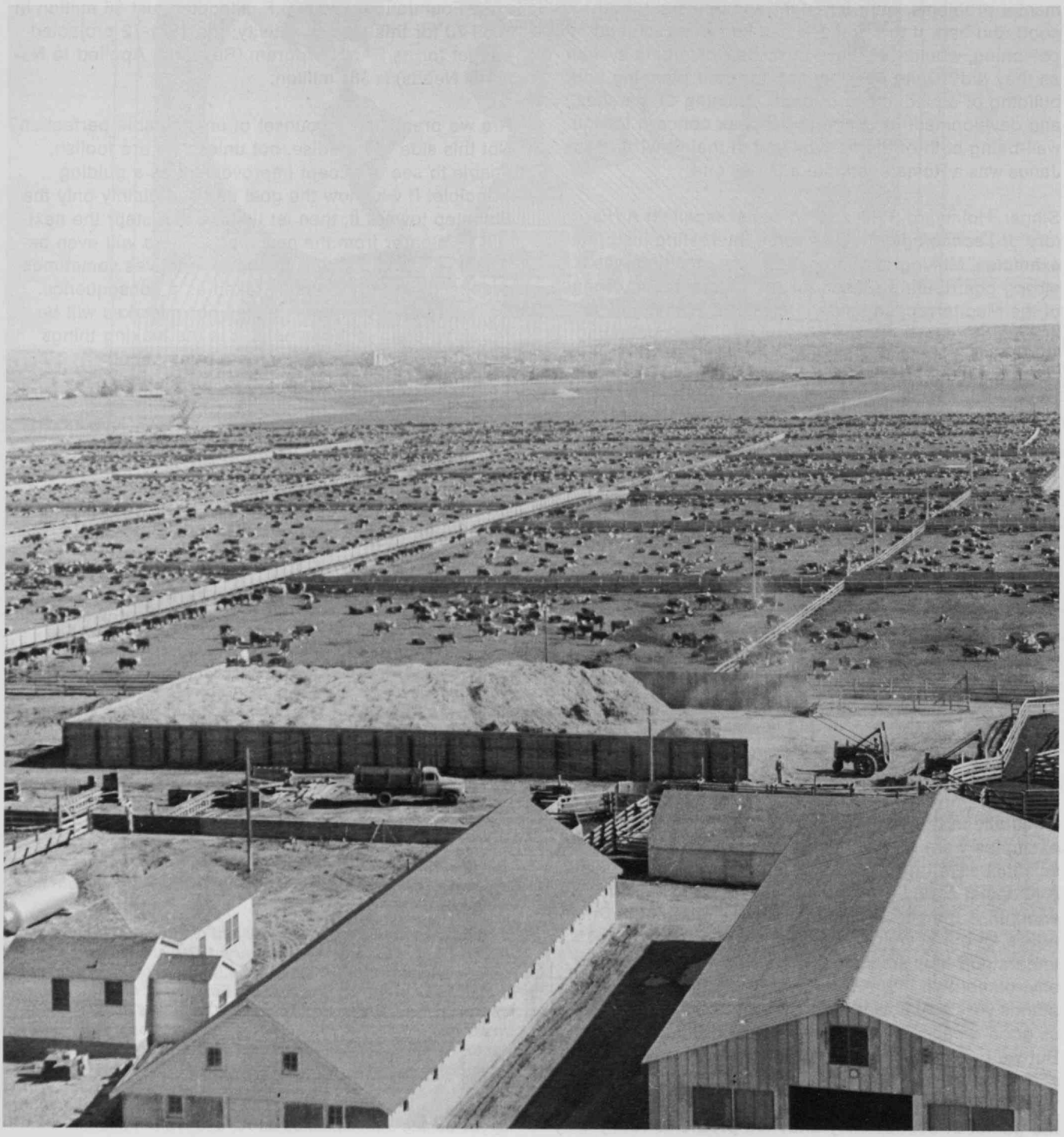
The present article is an abridgement of a longer study (Report O.R.N.L.-TM-2887, February, 1970) sponsored by an ad hoc *committee of the Oak Ridge National Laboratory. The original was prepared for Senators Edmund S. Muskie (Maine) and Howard H. Baker, Jr. (Tennessee) and was used by them in sponsoring Senate Bill S.3410 in the 91st Congress; Representative Joe L. Evins (Tennessee) and others sponsored a companion bill (H.R. 15778) in the House. The Senate bill has now, in essence, been reintroduced (as S.1113, March 4, 1971), and hearings related to its N.E.L. proposals will be held shortly by the Senate Subcommittee on Air and Water Pollution.*

"When flocks and herds were small, disposal of wastes posed no problem; the manure was hauled out and spread on the land. But cattle are no longer herded directly from the field to the railhead. . . . Giant feedlots have sprung up around the major cities. . . . Despite near-Herculean efforts at keeping the pens and feedlots clean and sanitary to meet federal regulations, the problem of waste management is overwhelming."



The industrialization of agriculture has been accompanied by a progressive departure from natural processes. Biological wastes that were formerly recycled now accumulate, presenting disposal problems of even greater magnitude than those of the cities

William E. Small
Editor, *Biomedical News*

Agriculture: The Seeds of a Problem

A hundred-odd years after President Abraham Lincoln signed the three basic laws which were to turn a forecast of famine into an agricultural revolution, America and most developed nations *(see pp. 6-7)* face a subtle but potentially far more disastrous crisis than the English prophet Thomas Malthus predicted.

That the immediate goals of increasing agricultural productivity were met beyond Lincoln's wildest dreams is unquestionable. But we now have a new set of problems to take the place of the famine predicted a century ago—problems that in the long run appear just as grim. Farming and forestry produce far more waste and contamination in the United States than do cities.

The volume of municipal wastes—including all kinds of garbage and "disposables"—has reached over 5 lbs. per person per day in this country—more than 1 billion lbs. per day; but the volume of wastes from livestock and poultry production alone is estimated at 1.7 billion tons annually—four times the amount of municipal wastes. Then there are crop and orchard wastes, food processing wastes, wastes from forestry, pulp and paper production, textiles, tanneries, and a host of "agrindustries." Quite separate issues are those of farm pesticides (of which there are traces in the bones and tissues of every man, woman, and child in the United States) and fertilizers.

As world population has increased, the demands on agriculture have not only intensified—requiring greater outputs—but have forced changes in the practices whereby this output is produced. At every stage, these technological changes appeared to follow upon economic needs. As we shall see, their side-effects present us with new tasks, the chief difficulties of which turn out to be economic. The switch away from natural organic fertilizers to inorganics has done double damage—first, by adding large quantities of long-lived highly stable chemicals to the soil, the air, and the waters, and second, by eliminating the practice of returning animal and crop wastes to the soil.

Today a single farmer can supply the needs of 26 persons. And so 25 persons live in cities for every one farmer, against only five a century ago. This mass migration to urban areas has resulted in high concentrations of poor in the black ghettos and inner cities. Many of these people, ironically, are malnourished.

On the global scale, even the much heralded "green revolution" appears to yield bitter fruit as the world population continues to match the growth curve of agriculture.

It is estimated by some experts that the world food supply must be doubled in order to feed adequately even the present population. Food production probably can be doubled or trebled by planting higher-yielding varieties which increase the yield per acre, by increased use of fertilizers and pesticides, and by increasing the acreage under cultivation. But it may be questioned whether the natural ecosystems, upon which we still depend for many "free services," can tolerate the disturbance which will result from such a large increase in food production using present methods.

Any increases in the acreage of cultivated land will be at the expense of pasture and forest and will increase storm-water run-off, erosion, and the silting of streams and reservoirs. (Soil erosion is particularly severe in the rainy tropics, where poor management has ruined large areas.) More water will be required for irrigation. Already there is a growing shortage of water in many areas, and the amount available for irrigation is limited by competition with human and industrial uses. Furthermore, the history of irrigation is discouraging: salt accumulation in the soil in irrigated areas decreases productivity, and has already made crop production impossible over large areas.

To see the impact of the progressive departure from natural cycles which has typified the agricultural revolution, let us examine the solid waste problem.

The Broken Cycle

Until recent years, animal wastes were considered valuable agricultural assets. The 1938 yearbook of the U.S. Department of Agriculture (U.S.D.A.), stated: "One billion tons of manure, the annual product of livestock on American farms, is capable of producing $3 billion worth of increase in crops. . . . The crop nutrients it contains would cost more than six times as much as was expended for commercial fertilizers in 1936. Its organic matter content is double the amount of soil humus annually destroyed in growing the nation's grain and cotton crops."

But farmers in the 1970's generally ignore the value of

organic fertilizer. The cost of labor and equipment for using it is high. And, they argue, the natural materials would in any case have to be supplemented with chemicals and minerals. In consequence, we suffer a great loss of valuable materials, while mountains of animal wastes overload barnyards. Lagoons and streams are overloaded with plant nutrients draining from farmlot and pasture.

The President's Science Advisory Committee, in a special section of its report *Restoring the Quality of Our Environment,* pointed out that "groundwater pollution arising from a disposal of livestock and poultry wastes may be evidenced in undesirable changes in taste, odor, and color of the water. Moreover, when manure treatment or storage areas are improperly located, the nitrate levels in immediately adjacent water supplies may become disturbingly high."

Organic nitrogen in barnyard manure is converted to nitrate, which in turn may pollute rural wells. This nitrate-rich water, despite the absence of indications of bacterial contamination, causes a disease called methemoglobinemia when consumed by infants.

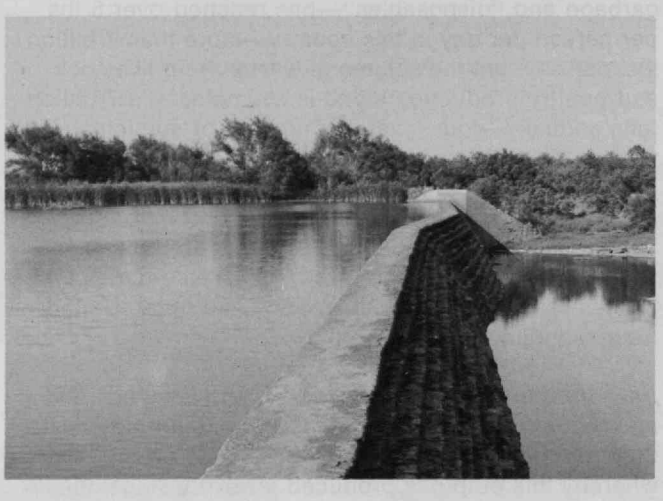
The amount of animal wastes generated in the United States is almost phenomenal. According to one government report, a cow generates as much manure as 16.4 humans, one hog produces as much waste as 1.9 people, and seven chickens are equivalent to one person, so that a typical chicken farm with 100,000 medium-sized broilers produces as much excreta as a town of some 15,000 people. Applying the statistics to the known numbers of various domestic animals, researchers found that farm animals in the United States produce ten times as much metabolic waste as the 200 million Americans.

When flocks and herds were small, disposal of wastes posed no problem; the manure was hauled out and spread on the land. But cattle are no longer herded directly from the field to the railhead for shipment to the city markets. Giant feedlots have sprung up around the major cities where cattle are held three to five months for fattening. Thousands of head of cattle are crowded into a few hundred square feet of space to spend their days eating high-protein diets to build up their weight and 'marble' their flesh. For example, in Illinois, just 216 farms market over 200,000 head of cattle in one year; these cattle produce as much waste as a city of 4 million people.

The trend toward confinement production is also common in the swine, poultry, and dairy industries. Some hog farms market 3,000 to 10,000 animals a year. One large chicken farm is reputed to house a million hens. Dairy farms generally range upward from 50 cows to more than 1,000, with mechanized milking equipment doing much of the work.

Despite near-Herculean efforts at keeping the pens and feedlots clean and sanitary to meet federal regulations, the problem of waste management is overwhelming. Well over a billion tons of feces, and about half again as much liquid waste, must be removed from animal pro-

"By far the most regrettable agricultural waste is the waste of soil itself." The top photograph shows a roadside ditch that was filled with sediment by a single rain. The two lower pictures are of Lake Ballinger Dam, in Texas, used from 1920 to 1952; originally, the water behind the dam was 35 ft. deep. (Photographs and information: Sediment, *U.S.D.A. Agriculture Information Bulletin No. 325)*



duction areas each year, regardless of the accessibility or availability of land for spreading. At present, much of the waste is washed from the feedlots into the nearby streams, or stacked in huge piles around the pens. Occasionally it is burned (although not, of course, as useful fuel, as is done in many undeveloped countries). Sometimes it is stored in pits or ponds, but this results in anaerobic fermentation which produces bad odors and dangerous quantities of ammonia, carbon dioxide, hydrogen sulfide, and methane gases.

Economic factors often limit the installation of effective measures for pollution control. Individual animal feeders cannot increase the price of their livestock to recover the costs of improved methods of waste control. The market for manure is limited. It is bulky and costly to handle, and farmers find it cheaper to buy concentrated commercial fertilizers than to try to spread large quantities of manure.

The health problems created by poor solid-waste practices are manyfold. Animal dung is a well-known breeding ground for flies and other insects that are known to carry a variety of diseases affecting man, among them rickettsiosis and Q-fever, which are similar to the common cold or flu. In addition, the crowding of animals in production areas has greatly increased the numbers of parasites affecting the meat we eat. New types of parasites are developing, particularly among the intestinal roundworms. The annual cost of parasitisms to the producer of livestock and poultry, estimated at more than $1 billion now, may be expected to increase with the concentration of agriculture; nobody knows the cost to society of diseases caused by animal parasites in man, but it, too, seems sure to rise.

A less direct challenge to the environment than manure are the wastes generated in the processing of meat for the table. Butchers used to say that they used everything from the pig but its squeal, and in truly efficient packing houses the waste from slaughtering and butchering is minimal. But it is not negligible. The daily discharges of waste water from meat-packing operations average more than 15 million gallons and contain at least 70 dry tons of suspended solids in addition to approximately 25 to 40 dry tons of animal fats. Most of the solids are scraps from the floor. (The protein content in these scraps and blood would be enough to feed several large cities.) The paunch or stomach content of the animals is mostly hay, and is coarse enough to foul up standard sewage systems. However, a new process has been developed in which the paunch manure is cooked and dried and fed to other cattle. The feed is extremely well accepted by the animals, perhaps because it is partly predigested.

Harvest Debris

Wastes from raw agricultural crops like fruits and vegetables, although less difficult to handle than animal wastes, nevertheless contaminate the environment in many ways. Field wastes were for centuries plowed back into the earth where they decayed as organic enrichment for the soil. But new cropping methods, particularly in the warmer regions of the country where two and three crops are now grown in a single season, have forced farmers to take these organics off the field before replanting. New methods of harvesting, developed as an answer to higher labor costs, are further complicating the situation. For every ton of tomatoes harvested by machines, three tons of waste products are left in the field.

Many vegetable wastes are burned. More than half of the approximately 240,000 acres of rice stubble in eight California counties is burned annually. Nearly one-third of the 900,000 acres of grass grown for seed each year is burned as a sanitation measure. Sugarcane and orchard wastes are also burned in large quantities throughout the United States.

An agriculture-related industry which has a tremendous waste-disposal problem is fruit and vegetable processing. Professor C. P. Steinberg of the Department of Food Science, University of Illinois, says that during the late summer and fall the fruit and vegetable canning industries produce waste with a biochemical oxygen demand (B.O.D.) equal to that of 80 million people. The reason the amount of waste is so great is because over half the material brought to the processing plant is usually refuse, which must be carried away, usually in a stream of water. The large amount of water in food processing makes it difficult to dispose of in any way except by dumping it into streams or sewage disposal plants.

Each crop has its own particular side-effect. Some, like cotton, give rise to heavy emissions of dust during processing (ginning); some, like peas and other fresh vegetables, contribute large quantities of sludge to sewage systems and hot, contaminated water to streams and rivers; some, such as peanut litter and rotting hay and straw, provide excellent breeding places for insects like the stable fly and housefly. Volunteer beets are a source of beet yellow virus, which reinfects subsequent beet crops. Pink bollworms winter over in waste cotton bolls and cotton seed left in the fields, and the European corn borer and sugarcane borer winter over in the stalks that remain in the fields.

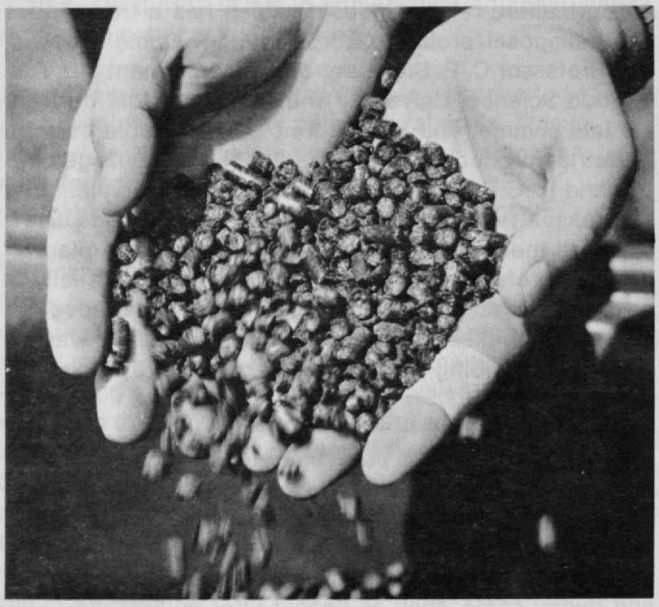
Some 18,000 industrial establishments now process farm products for food. In processing crops into food and fiber there are inevitably losses, which can be as high as 50 per cent of the raw material. Recently published data indicate that the pollution potential of these wastes is equivalent to that of a population of more than 168 million people.

Projections for the production of frozen fruits and vegetables indicate that waste in this industry will be a third higher by 1972 than it was in 1963. For some industries, such as dairies, the rate of waste-production will drop. But on the whole, wastes from food processing will continue to rise as the economy expands and buying power increases.

Forest Wastes

Forestry leaves an estimated 25 million tons of debris in the woods each year. Some of this is beneficial to the soil. But it is also a serious fire hazard and a

One way to reduce the volume of animal wastes to be disposed of: conversion into feed pellets. Barn wastes have unused nutritional value and can be chemically treated to improve digestibility and supplemented with meal. Tests at Beltsville, Md., have shown the resulting pellets to be acceptable to sheep. (Agricultural Research, Jan. 1971, pp. 3-4)



reservoir for diseases and pests. In the majority of the harvested areas, lumbering residues receive little if any care, although millions of dollars are spent each year to dispose of other forest wastes.

Some logging firms have tried crushing and burying forest wastes, or chipping and spreading the material. But studies show that this kind of waste handling can cost a prohibitive $20 to $60 an acre, or even more. Today, some forest residue is chipped or ground to produce low-grade construction materials, but transportation of these wastes makes it uneconomical to move them to a processing plant. Instead, most of the nation's wallboard and pressed woods are made from mill and lumberyard scraps.

Fires in U.S. forests—about 150,000 of them a year—have been estimated to release 34 million tons of particulates into the atmosphere annually, along with 338,000 tons of hydrocarbons, both of which contribute significantly to the total air pollution of the country. Burned-over forest areas also contribute heavily to water pollution. Excessive runoff and erosion dump untold amounts of sediments into the waterways, while ash kills fish and pollutes water intended for domestic, industrial, agricultural, and recreational uses. Some 5 to 7 million acres of forests are lost to fires each year, at a cost of over $1 billion. Forest fires are not in themselves a new phenomenon in nature. But it is well known that poor solid waste management has made a major difference: forest fires fed by logging wastes are more than seven times as large, on the average, as those in timbered-off areas from which such wastes have been removed.

There is also a disease problem associated with forest wastes, involving insect pests and fungi, which grow rampant in logging slash and brush piles, as well as foxes and other carriers of diseases (notably rabies), which den in piles of timber debris or use them as blinds to attack more valuable wildlife.

Fortunately, new lumbering interests and wood-using industries are beginning to attack the problems of forest wastes and the waste of wood products generally. Use of the total tree is still a long way off, but more and more natural-wood products are being sold to a variety of industries. The ever-expanding pulp and paper industries, and the plastics industries, have created a demand for a large portion of the tree that once was left to clutter the forest.

On the debit side of this development, it must be remembered that the wastes produced by pulp and paper mills are tremendous. In fact, the B.O.D. is higher for pulp and paper than it is for any other agricultural product. The acidic waste waters produced in processing and bleaching kill fish and other life downstream. Sludge deposits create turbidity and prevent the survival of many bottom animals. (See Henry I. Bolker's "Out of the Woods," pp. 22-29 for an account of current countermeasures.)

The Soil in the River

By far the most regrettable agricultural waste is the waste of soil itself. Only 4.5 billion acres of land on earth are suitable for agriculture. Of this more than half are estimated to be currently under cultivation. In the United States, less than 300 million acres or about 13 per cent of the total land is now being cultivated. The acreage of cropland per person has been decreasing.

The losses of precious topsoil over the past century or two have been incalculable. The Senate Select Committee on Natural Water Resources reported that "rough estimates of the suspended solids . . . reaching the nation's streams from surface runoff shows these to be at least 700 times the loadings caused by sewage discharge." According to the latest U.S.D.A. figures, sediment produced by erosion of the land probably averages at least 4 billion tons a year. Moved by flowing water from one place to another, about one-fourth of this material—more than a billion tons—reaches the major streams of the United States. The U.S.D.A. report *Control of Agriculture-Related Pollution* maintains: "Soil erosion and its effects are damaging many times over. First, there is the irreparable loss of soil that usually has taken many thousands of years to form. Second, sediments not only contribute heavily to suspended-solids pollution but also add to the dissolved-solids problem. Third, sediment frequently damages the area where it comes to rest, for example, lined canals where sediment furnishes a place for aquatic and other weeds to grow."

The storage capacity of artificial reservoirs in the United States is being reduced at the rate of about 1 million acre-feet each year. Wearing or abrasion of power turbines, pumping equipment, irrigation systems, and other equipment is accelerated by sediment. Commercial fisheries, particularly those for shellfish, and the habitats of gamefish, are damaged by sediment. And the deposition of sediment on bathing beaches and other recreation areas is unsightly and detracts from the use of these facilities. The cost: more than $500 million annually.

As if erosion by water were not enough, poor conservation practices in the Dust Bowl of the Southwest have removed billions of tons of soil as dust. Drifting dunes move over farms, burying roads and fences and houses. Texans and Oklahomans joke about having each other's soil when the wind shifts. But there is no joke about the fact that most of this soil is lost to agriculture.

Farmers have made considerable progress in bringing the soil into a more stable condition. Modern conservation practices, coupled with vast outlays of public funds, have helped restore some balance and prevent erosion. Private dams and public storage basins have been built across the nation to help check the ravages of water. Contour plowing and planting, terracing, and strip cropping have been widely used to give the soil some protection. Gullies have been filled or dammed and converted into farm ponds. And where wind erosion has been bad, shelter belts have been planted to break the eddies. But the waste of soil continues. The losses of two centuries can never be recouped. It takes 300 to 1,000 years to make an inch of good topsoil. The United States has lost thousands of years worth in a few decades.

Help for the Cities?

Now, to complicate matters, the cities are beginning to turn to the farms for help with disposal of urban wastes. As long as this means indiscriminate dumping of trash—paper, cans, bottles, old household junk—no good can come of it. Burying usable soil under useless litter hurts everybody. Fortunately, there is another side to this matter, however. The potential of rural open space and the need for organics on the land have recently led some farmers and city dwellers to begin to think in terms of putting the metabolic and industrial wastes—originally derived from the land—back into the natural cycle. (*see Robert B. Dean's article "Ultimate Disposal of Industrial Wastes: An Overview," in* Technology Review, *March 1971, pp. 20-25*).

A number of schemes have been advanced to get valuable urban solid wastes back into the soil. Solids removed as sludges from domestic waste waters (including, among other things, spent topsoil carried to the cities on fresh vegetables) can be incinerated to kill any micro-organisms and then trucked to farms for spreader application. Demonstration projects along these lines, started by the Metropolitan Sanitary District of Greater Chicago, have met with some success, and the University of Illinois has been working on this program to determine the agricultural benefits and environmental changes that might result from the use of digested sludge on field crops. Several companies are cleaning sewage effluents and selling heat-treated solids for garden and farm use, as are a number of municipally owned sewage treatment plants. However, any attempt to recycle sewage-disposal-plant wastes faces three problems: biological contamination, excessive accumulation of salt, and the cost of transport and application.

Most of this digested sludge is applied to agricultural land as a liquid containing less than 10 per cent of solids. If applied at the rate of 2 inches per acre it will supply over 500 pounds of nitrogen, 200 to 300 pounds of phosphorus, and 40 to 80 pounds of potassium. Other essential elements are present in adequate amounts. It also contains considerable amounts of chromium, zinc, copper, lead, nickel, and cadmium, raising the risk that some elements might accumulate to undesirable levels. More must be learned about the extent to which these elements are accumulated in plants and introduced into the food chain. The possibility of contamination of water with heavy metals must also be investigated.

The cost of transporting and applying sludge is rather high, and its use is likely to be local. Some sanitary districts are making almost continuous applications to nearby areas of grass and forest. Pennsylvania State University is piping sewage effluent directly into fields to use as irrigation water, leaving the residue of solids right in the water. Elsewhere, agricultural wastes are being recycled. Cheese whey is being sprayed on Wisconsin crop lands. Some Oregon farmers are spraying hog manure on to their grain, hay, and pasture fields, with no reported adverse effects. The effects of long-term continuous applications are still under study, but there is an encouraging possibility of successfully recycling this by-product of our cities.

Hog feeding, the classic route for food-wastes, continues to be a minor method for disposing of America's urban wastes. Almost 4 per cent of the nation's collected garbage is consumed by hogs, as compared with the 8 per cent that is incinerated. An average hog-feeding lot consumes about four tons of garbage a day.

If farmers are unable to cope with the wastes from their own farms, the chances are slim that they will be willing to lend a hand with the cities' solid wastes unless the price is good enough to make it worth-while. But with added incentives for all concerned, perhaps more of the nation's solid wastes will find their way back to the farms where they originated.

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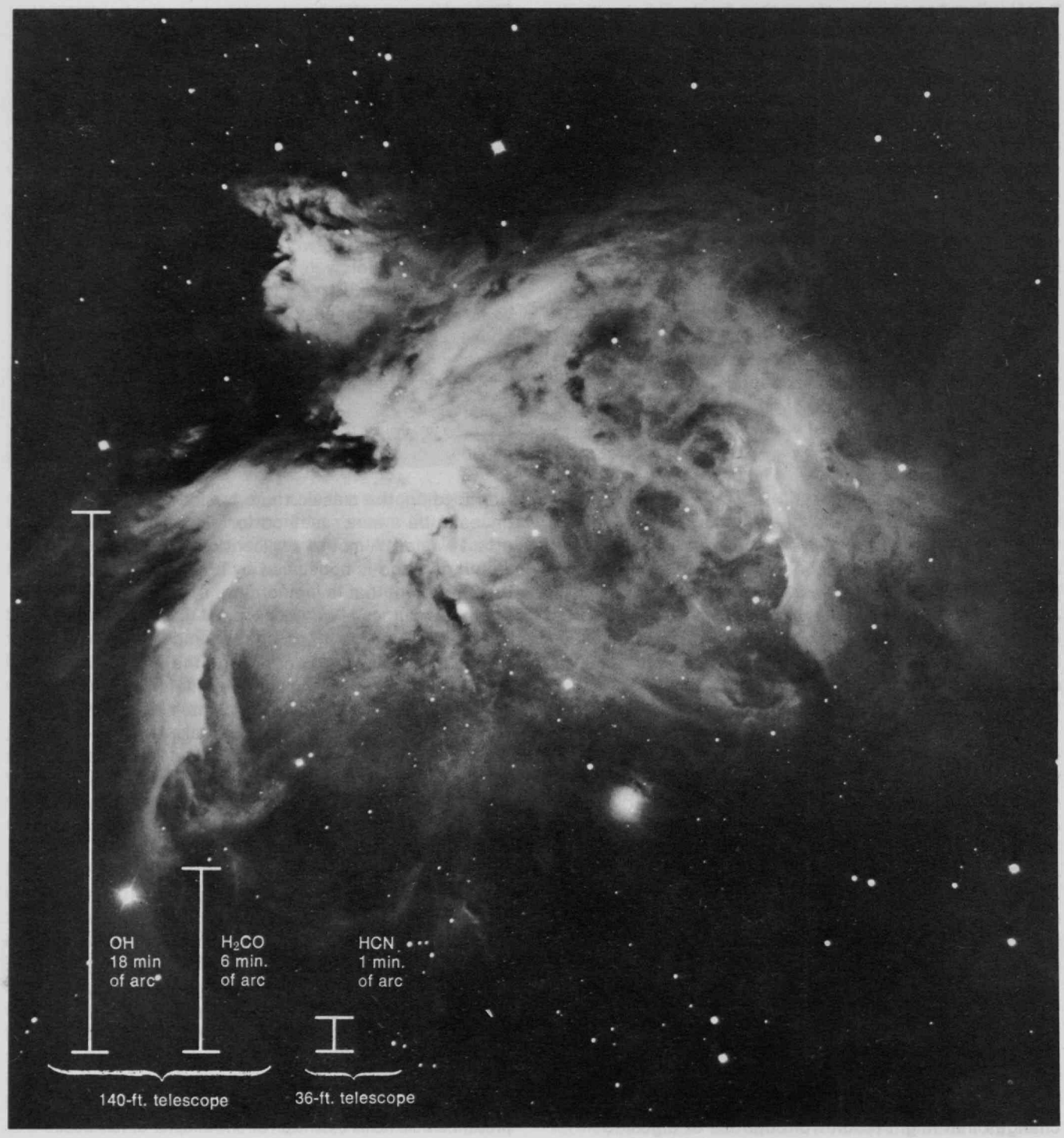
He is the author of Third Pollution: The National Problem of Solid Waste Disposal, *published this spring (Praeger). The present article is his extension of one chapter of this book.*

The Orion nebula is one of the nearby clouds of gas and dust (1,500 light years away) which exhibits many molecular lines. A large cloud of carbon monoxide has been found, which is about the size of this photograph. A 2-mm. line of formaldehyde has recently been found in Orion (although the 6-cm. line is absent) and lines from hydrogen cyanide, cyanogen, water, and hydroxyl have also been detected. The present resolution of radio telescopes is indicated to the same scale to illustrate the difficulty of obtaining detail comparable with optical photographs; the line labelled 18 min. of arc shows the resolution for the OH radical, the line labelled 6 min. of arc the resolution for formaldehyde, and the 1 min. of arc line shows the resolution for hydrogen cyanide. (Photo: Mt. Wilson Observatory).



Analysis of radio energy from outer space reveals a remarkably diverse molecular population in the interstellar clouds. Thus is born the new science of astrochemistry, from which may come understanding of the origins of planets and of life itself

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From Radio Astronomy Towards Astrochemistry

Radio astronomy is a relatively young science. It began 38 years ago with the detection of radio emission from the Milky Way by Karl Jansky. Subsequent advancements in radar technology supplied radio astronomers with some of the early antennas and receivers, and now radar itself has become an important astronomical tool as well as the source for much of the technology upon which radio astronomy depends.

Radar astronomy is simply the application of radar to objects in space; the reflection of a signal transmitted from earth makes it possible to measure the distance, rotation, and surface characteristics of a planet such as Venus. Radio astronomy, in contrast, is a passive activity: the reception of radio waves generated in the solar system, in many regions of our galaxy, and even beyond to the edge of the universe. Both radar and radio astronomy use the radio window—the region of the electromagnetic spectrum where the earth's atmosphere is mostly transparent—a wavelength range from 1 millimeter to 10 meters. By comparison, the optical-infrared window extends from 0.4 microns to 10 microns in wavelength.

Radio astronomy has led during the past 20 years to a remarkable series of exciting discoveries: the gigantic bursts of low-frequency radiation from the planet Jupiter, the extremely intense radio emission from very distant quasars whose angular sizes have been measured to be as small as 0.001 seconds of arc, and the very peculiar periodic radio signals from pulsars.

Radio astronomy received a great impetus with the discovery in 1951 by Ewen and J. D. Purcell of the 21-cm. wavelength emission from giant clouds of atomic hydrogen in our galaxy. Thus was the study of spectral lines introduced to radio astronomy.

Spectral lines are produced by atoms or molecules which radiate or absorb energy at discrete wavelengths. Each atom or molecule has its own particular radiation or absorption pattern—a series of lines—wavelengths in which it either radiates or absorbs energy. These lines are broadened by internal motions in the gas; and if the entire cloud in which they are generated is moving in relation to the earth they are displaced from the rest frequency by a doppler shift. Because the doppler equation relates the frequency shift to the molecules' velocity, the spectrum of a molecular cloud is usually displayed as a function of velocity in km./sec. Since 1951 the hydrogen line has been used extensively for mapping out the spiral arms in the Milky Way.

Searches for other radio lines, particularly from interstellar molecules, were unsuccessful until 1963, although the diatomic molecules CH, CH^+, and CN had been discovered by optical astronomers during the 1930's. Recently, however, our ideas of what constitutes the interstellar medium, the vast clouds of gas and dust which inhabit the region between the stars, have been thrown into an upheaval by the discovery of a number of complex molecules in these clouds. This discovery promises to revolutionize our concept of chemical evolution in the interstellar medium and may shed some light on the elusive question of the origin of life.

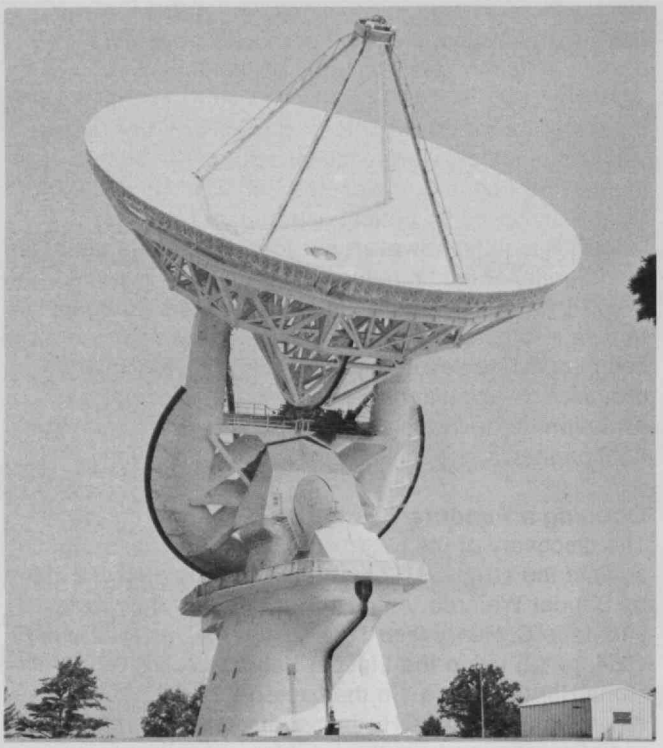
Opening a Pandora's Box

The discovery of the hydroxyl (OH) line in absorption against the strong radio source Cassiopeia A was made by Sander Weinreb, Alan H. Barrett, M. Littleton Meeks, and John C. Henry (*see* Technology Review *for January, 1964, p. 12*) using the Lincoln Laboratory's 84-foot Millstone Hill telescope. (In the case of absorption the intervening clouds of OH remove discrete amounts of the radiation coming from the bright radio source behind them at the hydroxyl wavelength of 18 cm.) This followed several years of searching for OH, and the detection was greatly aided by a new type of autocorrelation receiver, developed by Dr. Weinreb to distinguish by computer-aided analysis between random noise and the nearly hidden useful spectra.

In 1965 the anomalous OH emission, originally called "mysterium" because of the narrow line widths, large intensities, and strange line ratios, was discovered simultaneously by a group at Berkeley (Harold F. Weaver, N. H. Dieter, and D. R. W. Williams) and a group at Harvard (E. Gunderman, S. J. Goldstein, and A. Edward Lilley). It is now known that these peculiar lines are produced by interstellar amplification on the maser principle, but the exact mechanism is a matter of considerable debate. (Maser is the well-known acronym for *M*icrowave *A*mplification by *S*timulated *E*mission of *R*adiation.) The interstellar maser amplifies radiation from an interstellar cloud using energy supplied either by radiation or by collisions between the amplifying molecules and interstellar hydrogen atoms, protons, or electrons. This input energy is commonly referred to as

The 140-ft. telescope of the National Radio Astronomy Observatory in Green Bank, W. Va., has a 413-channel auto-correlation receiver which makes this instrument particularly suitable for molecular line studies. Formaldehyde was discovered with this telescope in March, 1969, and more recently it has been used to detect cyanoacetylene, methyl alcohol, and formic acid. Spectral line observations have been made at wavelengths down to the water vapor line at 1.35 cm.

The National Radio Astronomy Observatory's 36-ft. telescope on Kitt Peak in Arizona and has been used during 1970 to discover interstellar carbon monoxide, hydrogen cyanide, X-ogen, and the first radio line of the cyanogen radical. The dome-enclosed telescope has an azimuth-elevation mount with direct drive of the telescope axes; it has been used at wavelengths as short as 1 mm. (Photos: N.R.A.O.)



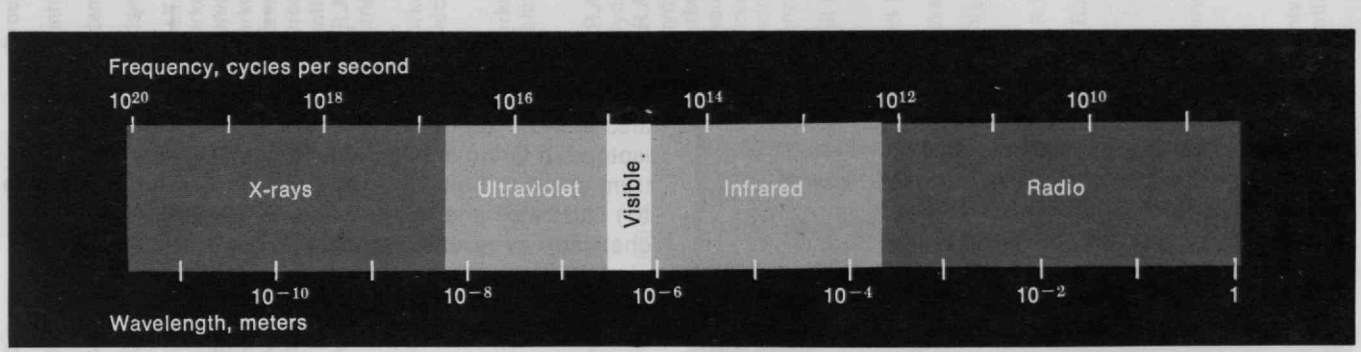
a "pumping" source. While the pump may be spread over a considerable range of energy, its end effect is observed as the amplification of a single microwave line, thus converting a percentage of the extended energy of the pumping source into a narrow emission line.

The early optical observations of the 1930's demonstrated the existence of CN and CH in the interstellar medium. Molecules containing carbon, nitrogen, and oxygen were clearly suggested by these radio and optical data. However, many astronomers were reluctant to accept the existence of polyatomic molecules under the harsh conditions of ultraviolet radiation and high-energy cosmic rays that exist in interstellar space. What was overlooked was the importance to their survival of low temperatures (1° to 100° K.) and low densities (less than 1 molecule/cc.) as well as the presence in space of dust "grains" which are apparently essential for the formation and preservation of complex molecules.

It was in 1955 that Charles H. Townes suggested a search for several possible planetary and interstellar molecules. However, since polyatomic molecules were considered unlikely to survive in the interstellar medium, no effort was made to look for anything more complex than diatomic molecules. Only in 1968 were groups at the University of California (Berkeley) and the National Radio Astronomy Observatory ready to search for complex interstellar molecules. At the University of California Dr. Townes and W. J. Welch along with A. C. Cheung, D. M. Rank, and D. D. Thornton focussed attention on a search for ammonia, while at the same time the authors at N.R.A.O. were preparing a search for interstellar water clouds. The spectacular detection of both molecules by the Berkeley group late in 1968 opened a Pandora's box of possibilities concerning the chemistry of interstellar space.

The ammonia line exhibited relatively normal emission, with most of the molecules in the lowest energy levels, as found under low-temperature laboratory conditions. But the water exhibited very anomalous excitation, with higher energy levels significantly populated—suggesting an extremely high excitation temperature, similar to the masering OH lines. Signal intensities as high as 4,500° K. have been measured on the N.R.A.O. 140-foot telescope, something equivalent to having the sun fill the entire antenna beam—hence the

For centuries man's observations of the planets and stars were limited to visible phenomena, events recorded in a very narrow band of the electromagnetic spectrum. Radar and other sophisticated electronics have now opened the radio spectrum, and the result is a wholly new astronomy revealing new materials and new processes in space and leading to the new science of astrochemistry.



synonymous expression "antenna temperature." Yet the angular size of the sources as determined from very-long-baseline interferometry experiments is less than 0.01 seconds of arc (*see* Technology Review, *for June, 1970, p. 76*).

An Organic Laboratory in Space?

The discovery of formaldehyde in March, 1969, began a series of organic molecule detections. Of these, formaldehyde itself is probably the most interesting. The observations, made by the authors along with Benjamin M. Zuckerman and Patrick Palmer, showed a normal absorption spectrum everywhere except in the dark clouds —the regions in interstellar space where radiation is absorbed and hence which appear dark to terrestrial observers. In these dusty regions absorption lines were seen without background sources, thus indicating that formaldehyde molecules were absorbing radiation from the 3° K. microwave background. This situation is the reverse of the maser, where the upper state of a molecule becomes overpopulated. In this case the lower state is overpopulated, giving an excitation temperature of less than 2° K. This can be accomplished under rather special circumstances by collisional pumping, a process which involves the collision of hydrogen atoms, protons and electrons with the formaldehyde molecules. The kinetic energy of the collision excites the formaldehyde into a higher energy state. Subsequent decay of the formaldehyde molecules to lower energy levels leaves the lower state overpopulated, producing an inverse maser or refrigerator which absorbs—rather than emits—energy.

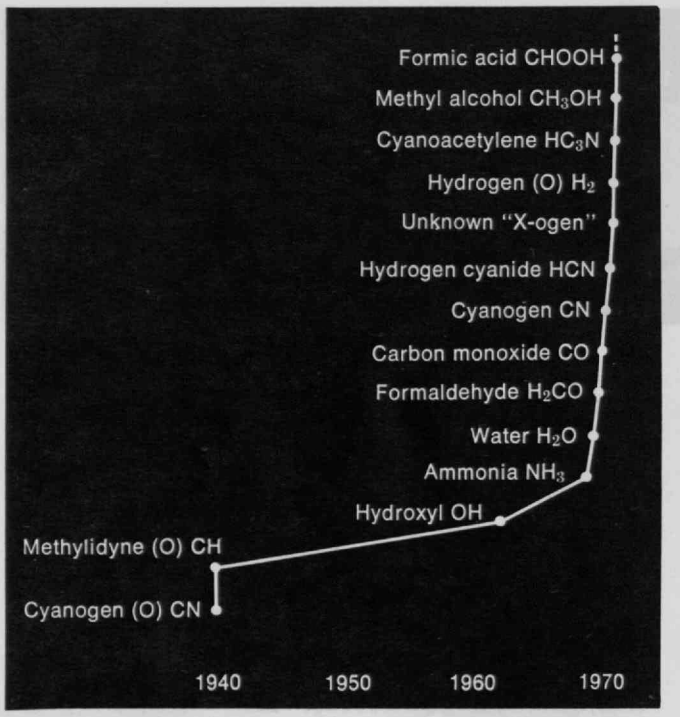
Here we have an example of a new physical phenomenon being demonstrated by dust clouds in our galaxy. The molecular refrigerator is just one of many surprises which result from the effort to understand the chemistry and physics involved in the new molecular-line discoveries.

Formaldehyde has been found in absorption against at least 50 radio sources in our galaxy, and it seems to be —along with hydroxyl and hydrogen—a very common constituent of the galactic spiral arms. The spectrum shown for the galactic center (*page 61*) illustrates the multiple features seen in several of the radio sources.

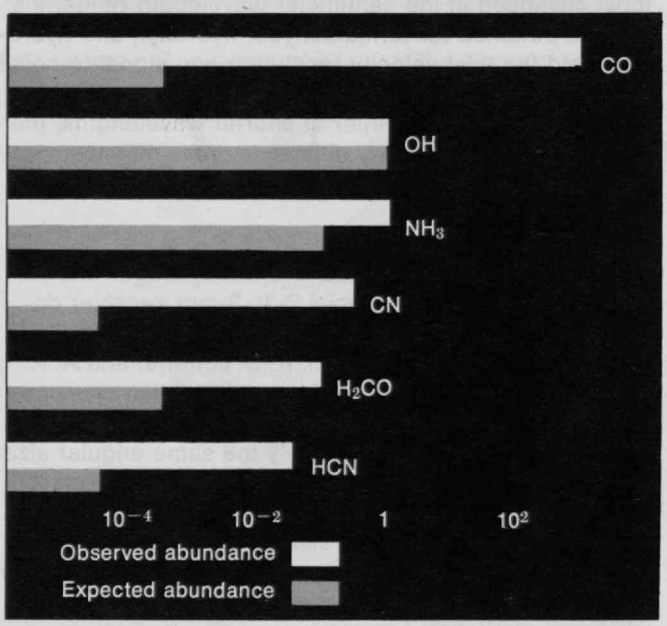
The velocities generally match those observed in hydroxyl and hydrogen. Because receiver technology is most advanced in the centimeter wavelength range, the spectra obtained for formaldehyde, hydroxyl, and hydrogen yield the best velocity resolution and signal-to-noise ratio. However, since telescope beamwidth and hence spatial resolution are better at shorter wavelengths, the millimeter-wave lines may ultimately prove the most useful for high-resolution probing of galactic molecular clouds.

Lines from carbon monoxide and the cyanogen radical were detected using a special 2- to 3-mm. receiver developed by Bell Telephone Laboratories and N.R.A.O. in April, 1970, by R. W. Wilson, K. B. Jefferts, and A. A. Penzias. The carbon monoxide cloud in Orion was particularly interesting because of its size: it is 30 minutes of arc in diameter (approximately the same angular size as the moon). At the distance of Orion the cloud must be 15 light-years in diameter. The antenna temperature of 40° K. requires that the excitation temperature of the molecule be approximately 100° K. A similar situation occurs in the ammonia cloud in the galactic center, where an excitation temperature of 50° K. is maintained in a cloud 100 light-years in diameter. How these high temperatures are produced over such large regions is a remarkable astrophysical problem.

Fourteen different molecules have been discovered in interstellar space since 1937, when the first optical spectra were found and subsequently identified. Complexity of the molecules discovered has increased considerably with the recent addition of microwave lines from a number of organic molecules (chart below—optical findings are indicated by 0). The table opposite does not include 25 interstellar diffuse bands in the optical spectrum found by several astronomers. Although the earliest of these was discovered by P. W. Merrill in 1934, they have yet to be identified. Radio lines from atomic hydrogen and recombination lines from ionized hydrogen are also not included.



The abundances of various interstellar molecules deviate markedly from the expected abundances based on cosmic abundances of the various constituent atoms. The chart shows the differences between the observed and expected abundances, normalized to the hydroxyl molecule; the differences reflect the chemical reactions which produce the molecules and their relative stability in interstellar space.

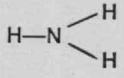
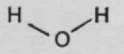
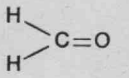
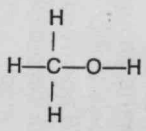
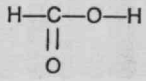


In June, 1970, we used a 3-mm. microwave receiver developed by N.R.A.O. to detect hydrogen cyanide, which appeared in emission in six galactic radio sources. We also found hydrogen cyanide containing the carbon-13 isotope in Orion and the galactic center, and the spectrum showing both carbon-12 and carbon-13 lines (*page 61*) illustrates another puzzling feature of interstellar chemistry as revealed by molecular lines. Data from our observations indicates that the carbon-13 isotope line is much too strong; it is one-ninth the abundance of the carbon-12 hydrogen cyanide when, according to terrestrial abundance ratios, it should be 1/89. Similarly strange isotope-line ratios have also been observed in carbon monoxide and formaldehyde. The interpretation of these results is still an open question.

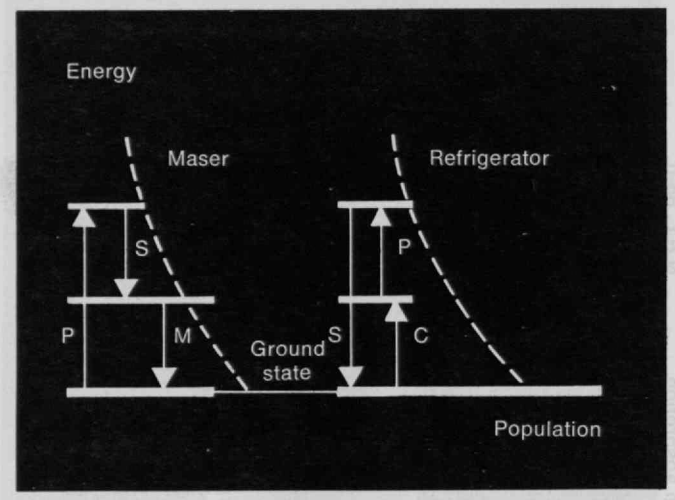
The search for the carbon-13 isotope of hydrogen cyanide uncovered another spectral line which we cannot positively identify. The line is at a frequency of 89.190 GHz, and we are calling it X-ogen because of its unknown extraterrestrial origin. One possible identification is with a predicted line of HCO^+ suggested by W. Klemperer. However, this molecular ion is difficult to work with in the laboratory and so this identification is difficult to verify. It seems likely that X-ogen, like the optical diffuse bands discovered thirty years ago by P. W. Merrill, will remain an enigma for some time.

Recently a new group of molecular lines has been found which reinforce the belief that interstellar space is a gigantic organic chemistry laboratory. The first new molecule, cyanoacetylene, found by B. E. Turner in July, 1970, represents the first example of a long-chain organic molecule in space. A chain of three carbon atoms with single and triple bonds forms the backbone of this linear molecule, and its discovery proves that large molecules with intricate carbon bonding can exist in interstellar clouds.

Methyl alcohol has been found recently by John A. Ball, Carl Gottlieb, A. Edward Lilley, and Harrison E. Radford from Harvard. Dr. Zuckerman along with the Harvard group also detected a very weak signal from formic acid. Indeed, it now appears that interstellar space contains a rich variety of molecules and that chemical evolution has proceeded much farther than any scientist would have postulated even as recently as two years ago.

Year	Molecule	Symbol	Structure	Wavelength	Type of signal	Telescope	Group
1937		CH	C—H	4300 Å	Optical absorption	Mt. Wilson 100-in.	Dunham/Swings and Rosenfeld
1940	cyanogen	CN	C≡N	3875 Å	Optical absorption	Mt. Wilson 100-in.	Adams/McKellar
1941		CH^+	$C—H^+$	3745-4233 Å	Optical absorption	Mt. Wilson 100-in.	Adams/Douglas and Herzberg
1963	hydroxyl	OH	O—H	18 cm.	Normal absorption	Lincoln Laboratory 84-ft.	M.I.T.: Weinreb, Barrett, Meeks, and Henry
				18 cm.	Maser emission	Hat Creek 85-ft. Agassiz 60-ft.	Berkeley: Weaver, Dieter, and Williams Harvard: Gunderman, Goldstein, and Lilley
				18 cm.	Normal emission	Hat Creek 85-ft.	Berkeley: Heiles
				6.3 cm.	Maser emission	N.R.A.O. 140-ft.	Harvard: Zuckerman, Palmer, Penfield, and Lilley
				5.0 cm.	Maser emission	Algonquin 150-ft.	Toronto/Harvard: Yen, Zuckerman, Palmer, and Penfield
				2.2 cm.	Maser emission	N.R.A.O. 140-ft.	N.R.A.O./Univ. of Chicago/Univ. of Maryland: Turner, Palmer, and Zuckerman
1968	ammonia	NH_3		1.3 cm.	Normal emission	Hat Creek 20-ft.	Berkeley: Cheung, Rank, Townes, Thornton, and Welch
1968	water	H_2O		1.3 cm.	Maser emission	Hat Creek 20-ft.	Berkeley: Cheung, Rank, Townes, Thornton, and Welch
1969	formaldehyde	H_2CO		6.2 cm.	Normal absorption	N.R.A.O. 140-ft.	N.R.A.O./Univ. of Chicago/Univ. of Maryland: Snyder, Buhl, Zuckerman, and Palmer
				6.2 cm.	Refrigerator absorption	N.R.A.O. 140-ft.	N.R.A.O./Univ. of Chicago/Univ. of Maryland: Snyder, Buhl, Zuckerman, and Palmer
				2.1 cm.	Normal absorption	N.R.L. 85-ft.	Berkeley/Naval Research Laboratory: Evans, Cheung, and Sloanaker
				1.0 cm.	Normal absorption	Hat Creek 20-ft.	Berkeley: Welch
				2.1 mm.	Normal emission	N.R.A.O. 36-ft.	Goddard/Bell Labs: Kutner, Thaddeus, Jefferts, Penzias, and Wilson
1970	carbon monoxide	CO	C=O	2.6 mm.	Normal emission	N.R.A.O. 36-ft.	Bell Labs: Wilson, Jefferts, and Penzias
1970	cyanogen	CN	C≡N	2.6 mm.	Normal emission	N.R.A.O. 36-ft.	Bell Labs: Wilson, Jefferts, and Penzias
1970	hydrogen	H_2	H—H	1100 Å	Ultraviolet absorption	Rocket Camera	Naval Research Laboratory: Carruthers
1970	hydrogen cyanide	HCN	H—C≡N	3.4 mm.	Normal emission	N.R.A.O. 36-ft.	Univ. of Virginia/N.R.A.O.: Snyder and Buhl
1970	X-ogen	?	?	3.4 mm.	Normal emission	N.R.A.O. 36-ft.	N.R.A.O./Univ. of Virginia: Buhl and Snyder
1970	cyano-acetylene	HC_3N	H—C≡C—C≡N	3.3 cm.	Normal emission	N.R.A.O. 140-ft.	N.R.A.O.: Turner
1970	methyl alcohol	CH_3OH		36 cm.	Normal emission	N.R.A.O. 140-ft.	Harvard: Ball, Gottlieb, Lilley, and Radford
1970	formic acid	CHOOH		18 cm.	Normal emission	N.R.A.O. 140-ft.	Univ. of Maryland/Harvard: Zuckerman, Ball, Gottlieb, and Radford

An energy level diagram for the maser and "refrigerator" is shown to illustrate the path a molecule follows in producing anomalous emission or absorption. The input pumping energy is indicated by the transition (P), the spontaneous emission by (S), the maser emission by (M) and the cooling transition by (C). The normal undisturbed population of the energy levels is indicated by the dotted line and the number of molecules in a given level is indicated by the length of the horizontal bar. Note that the direction of the arrows is reversed in going from a maser to a refrigerator.



At the other end of the molecular scale, the recent detection of ultraviolet absorption from molecular hydrogen by George R. Carruthers provides a tentative answer to a long-standing question. The problem concerns how much of the mass of the galaxy is tied up in molecular hydrogen. With so much atomic hydrogen in existence it was obvious that some molecular hydrogen should exist, but absorption by molecular hydrogen has so far been detected against only one star. The experiment is difficult; it requires rocket observations at a wavelength of 1100 Å using a specially developed photoelectric camera. But Dr. Carruthers' observation now reveals that one-quarter of the hydrogen in the one cloud observed is in molecular form. This result should be considered preliminary until further observations are made.

Measuring Movements and Abundances

Observation of molecular lines provides the astronomer with an important tool for studying interstellar clouds. The radial velocity of the cloud can be measured by measuring the difference in frequency of a line from a known molecule observed in an interstellar cloud and the same molecular line measured under laboratory conditions. In addition, the line width can be used to indicate the existence and character of turbulence within a cloud. Normal emission lines can also give a clue to the temperature of a cloud, though it is very difficult to determine a single unambiguous temperature because most interstellar clouds are not in thermal equilibrium. The molecules are exposed to a radiation temperature which may be as low as 3° K. in regions remote from any nearby stars and to a kinetic temperature which, from observations of hydrogen, appears to be of the order of 100° K.

The interstellar maser and inverse maser are among the intriguing consequences of this nonequilibrium situation. The water and hydroxyl molecules have very strong and narrow lines produced by maser action, even though their energy level structures are entirely different. Pumping by radiation or collisions is considered the major means of producing the population inversions which then give rise to maser action when photons are amplified as they pass through the cloud.

The water maser exhibits some very interesting behavior. Observations of Mira variable stars by Philip R. Schwartz and Alan H. Barrett of M.I.T. reveal that the intensity of the water line varies in phase with the light coming from these stars. This indicates that the pumping energy is coming from the star; however the details of this process are not well understood. Despite considerable study by both Litvak and Turner of the exact mechanism for pumping and population inversion in the hydroxyl and water molecules, our understanding of the interstellar maser is still very primitive.

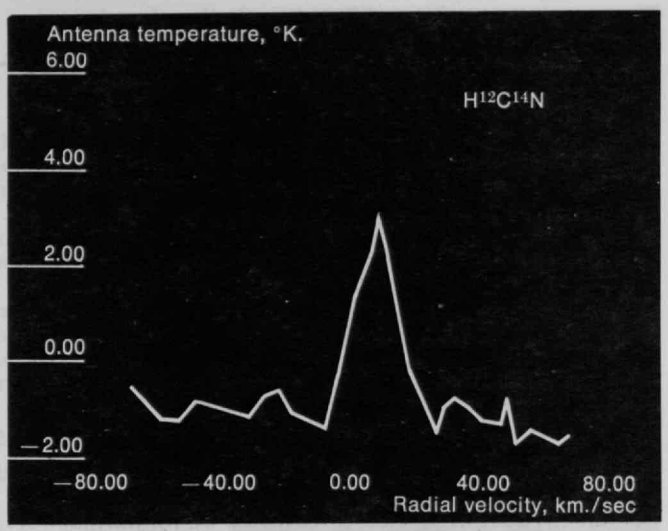
The inverse maser is very similar to a refrigerator. Pumping of the formaldehyde molecule produces an overpopulation of the lower state, or "cooling" with respect to the higher states. Anomalous absorption can then occur whenever the molecule encounters a passing photon. The pumping may be caused by hydrogen atoms which are slowed down or cooled by collisions with the molecules. Such an interstellar refrigerator is apparently important in cooling clouds of hydrogen during the early stages of condensation into a star.

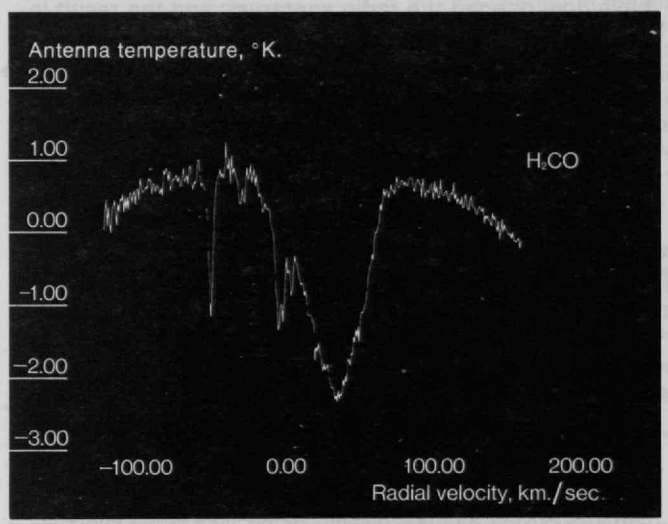
The maser provides another means of similarly cooling the hydrogen. For example, if the H_2O molecule is pumped by collisions, the kinetic energy of the hydrogen atoms is given to the H_2O molecules in the process of exciting them into the upper state. The masering transition then radiates away the energy which was provided by the hydrogen atoms. It is interesting that the rate of energy release during the collapse of an interstellar cloud is similar to the power radiated by some of the strong H_2O masers. Furthermore, Bernard F. Burke and his collaborators at M.I.T. have shown that the water masers are about the same size as the solar system. Thus we hypothesize that the molecular maser may be crucial during the early stages of the formation of stars and planets.

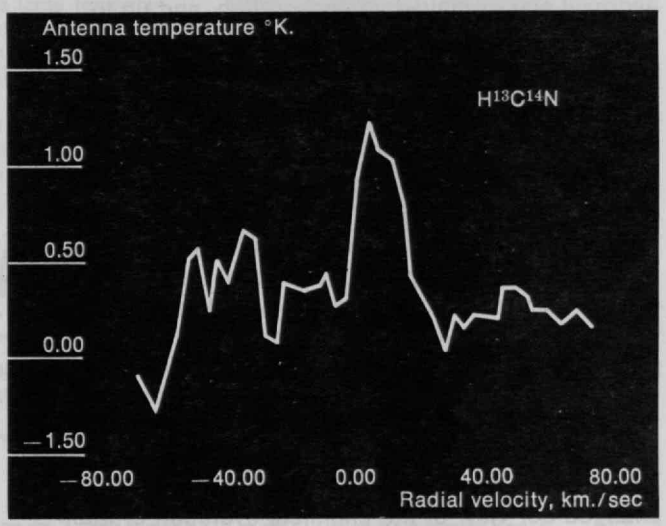
The abundances of the various molecules which have been discovered in interstellar space are in some cases quite peculiar. Carbon monoxide is generally more plentiful than any other molecule with the exception of hydrogen, a curious balance for which there is no terrestrial precedent. In addition, the amount of formaldehyde relative to hydroxyl is too high. Thus these two organic molecules which contain the carbon-oxygen bond seem to be better suited to interstellar conditions than, for example, ammonia.

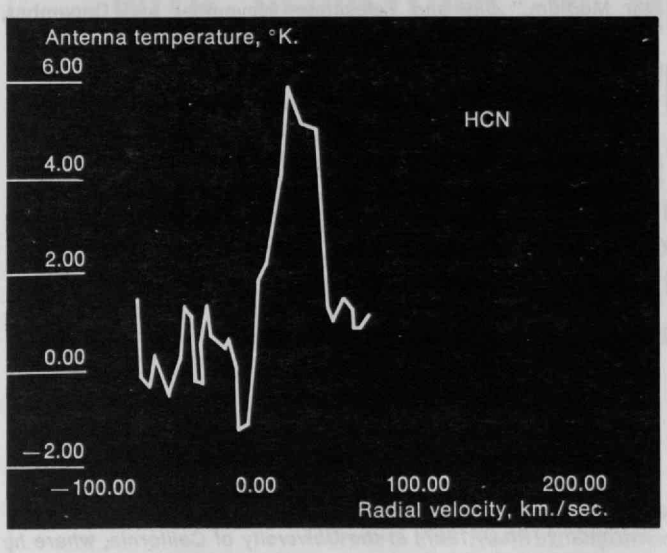
Molecular spectra (below) *for formaldehyde and hydrogen cyanide in the galactic center reveal the excitation state and the movement of these molecules. The wide feature at +40 km./sec. is typical of most molecules found in the galactic center. The narrow features seen in formaldehyde represent the cross-section of several spiral arms.*

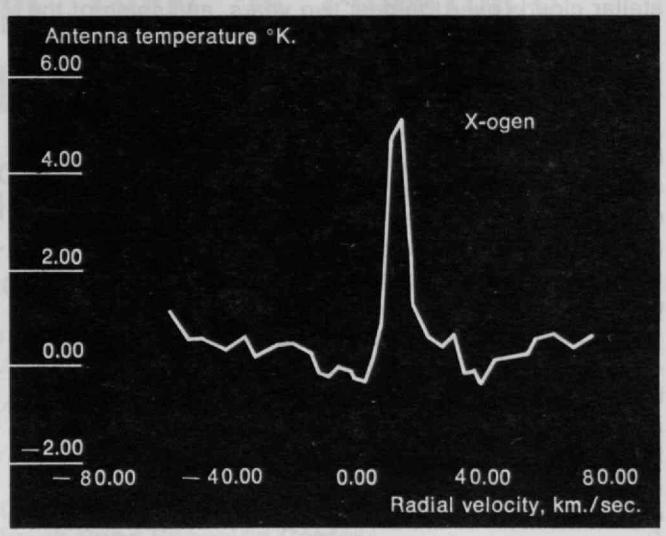
Spectra at the right reveal the presence of hydrogen cyanide, its carbon-13 isotopic form, and X-ogen in the Orion nebula. The strong carbon-13 isotope line is one of the puzzles of radio molecular spectra.











There are also regional differences in the abundances. Ammonia and some of the recently discovered complex organic molecules are only found in the galactic center. Many hours of data had to be averaged to produce a single spectrum for formic acid and methyl alcohol, the two organic molecules found recently in the galactic center by the Harvard group.

An interpretation of molecular abundances is essential for understanding the basic chemical and physical processes taking place in the interstellar medium. But a number of problems arise in the calculation of molecular densities. One problem is related to the temperature of an interstellar cloud, since the excitation temperature enters directly into determining the density of molecules such as hydroxyl and formaldehyde. These excitation temperatures range from approximately 1° K. for the formaldehyde refrigerator, through 10° K. for normal hydroxyl and formaldehyde absorption, and up to 100° K. for carbon monoxide emission.

Another difficulty concerns the degree of saturation of the molecular lines. With present telescope resolution we cannot distinguish between a thin cloud filling the entire telescope beam and many small thick clouds only partially filling the beam. The existence of small, dense clouds in the galactic center and Orion could explain the abnormally strong isotope lines of formaldehyde, carbon monoxide, and hydrogen cyanide observed there. Large millimeter-wave telescopes or spectral-line interferometers may make possible the resolution of this problem.

Enter the Science of Astrochemistry

The study of interstellar molecules has radically changed our view of the chemical evolution of interstellar clouds over the past two years, and some of the implications are only now being realized. It is clear that molecular masers and refrigerators provide an important means of energy conversion, which could be important in the early stages of planet and star formation, but the details are not well understood. The abundances of many molecules seem peculiar, with the organic molecules generally predominating. Bertram Donn, an astrophysicist who has spent many years studying interstellar grains, believes that they may be large macromolecules of carbon in various ring configurations; such grains may provide catalytic surfaces for the formation of molecules. Molecules formed on such surfaces under the low-density and low-temperature conditions of the interstellar medium are subsequently released into the interstellar medium. Since many millions of years elapse between the birth of a cloud and its eventual collapse into stars and planets, the molecules have a chance to accumulate until they reach an equilibrium where the formation rate is equal to the destruction rate. Interpretation of the present results will depend heavily upon detailed studies of the formation and destruction reactions which take place under interstellar conditions. Undoubtedly this is the beginning of the new science of astrochemistry.

The implications for the biological evolution of life are a most startling aspect of this newly emerging branch of astronomy. Most of the molecules found so far are important in reactions which synthesize amino acids. Laboratory experiments by Stanley Miller and recent work by Cyril Ponnamperuma suggest that hydrogen cyanide is a key molecule in these reactions, which generally start with ammonia, water, and methane. Although nothing is known about the microwave spectra of amino acids, it is now possible to search for similar complex organic molecules in the interstellar medium. Thus we are learning something about the possible seeds of life existing in clouds out of which planets are being formed in other parts of our galaxy, and we are also discovering what conditions may have been like in our own solar nebulae five billion years ago.

For centuries man's observations of the planets and stars were limited to visible phenomena, events recorded in a very narrow band of the electromagnetic spectrum. Radar and other sophisticated electronics have now opened the radio spectrum, and the result is a wholly new astronomy revealing new materials and new processes in space and leading to the new science of astrochemistry.

Suggested Readings:

Fred Hoyle, *Frontiers of Astronomy*. New York: Harper and Row, 1955.

Fred Hoyle, *The Black Cloud*. New York: Harper and Row, 1958.

Paul W. Merrill, *Space Chemistry*. Ann Arbor: University of Michigan Press, 1963.

A. G. Pacholczyk, *Radio Astrophysics*. San Francisco: W. H. Freeman, 1970.

Cyril Ponnamperuma, *Exobiology*. North-Holland, 1971.

Lewis E. Snyder and David Buhl, "Molecules in the Interstellar Medium," *Sky and Telescope*, November and December, 1970.

David Buhl joined the scientific staff of the National Radio Astronomy Observatory—where he found himself in charge of work on the solar system—in 1967. Earlier he had studied electrical engineering (S.B. 1958, S.M. 1960) at M.I.T. and astronomy (Ph.D. 1967) at the University of California, where he was associated with the Lawrence Radiation Laboratory in a variety of engineering projects. Lewis E. Snyder went to N.R.A.O. in 1967, following academic work at Indiana State University (B.S. 1961), Southern Illinois University (M.A. 1964), and Michigan State University (Ph.D. 1967); he has held his present post at the University of Virginia since 1969. During the past three years Drs. Buhl and Snyder have collaborated in the search for molecular lines in the interstellar medium. Coming in second on the detection of water vapor in the galaxy, they went on to discover formaldehyde, hydrogen cyanide, and X-ogen. Since these molecules are important in the chemical evolution of life, the two are continuing their collaboration to look for other links in the evolutionary chain.

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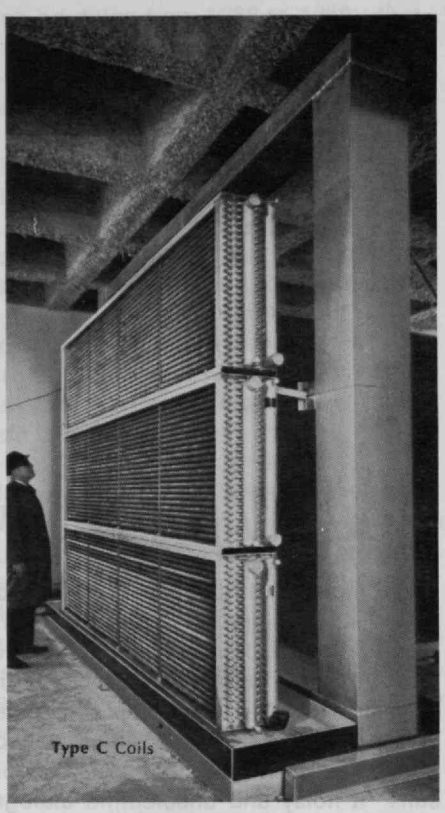

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Trend of Affairs

Resolving Polywater

If you place some capillaries—tiny tubes 100 microns (0.004 in.) in diameter—above a bowl of water and thus in the presence of varying amounts of water vapor, the capillaries will presently collect a fluid. Sometimes it is —at least partly—water; but sometimes it is something else, an anomalous watery liquid called "polywater" which has been the subject of what one participant calls "a noisy and unscientific dialogue" for nearly a decade.

Denis L. Rousseau of the Crystal Physics Research Department of Bell Telephone Laboratories, Inc., is convinced that the controversy is over. "Polywater" is not really a new form of water at all; it is simply a demonstration of how pervasive are the by-products of man's daily life.

But S. Barry Brummer, Assistant Director of the Corporate Research Division at Tyco Laboratories, Inc., still thinks that there are too many unanswered questions. He and his colleagues can consistently produce two kinds of "polywater" in their laboratories, and they insist that their products have characteristics which cannot be explained by anything short of the kind of specific difference in molecular structure that separates one polymer from another.

If Dr. Brummer and his group make their "polywater" in quartz capillaries, its molecular weight is just under 200; if they make it in pyrex tubes, its weight may be as much as 60 units less. But the molecular weight of ordinary water is only 18. Both forms of "polywater" turn out to be more viscous and have a higher surface tension than water; both solidify at about —40° C. and distill at 300° C.; their refractive index is 1.48 compared with 1.33 for water; the spectrum of polywater is constant—and different from that of water.

To prove his case conclusively, Dr. Brummer told a meeting of the American Chemical Society at M.I.T. this winter, he must make larger—at least macroscopic —quantities of "polywater," so that experiments can be carried out on a scale large enough to convince even the most persistent doubters; and he must show that his product is identical with the "polywater" which others obtain from similar—or different—apparatus.

When his turn came, Dr. Rousseau summarized for the A.C.S. members more than one year of the most precise analytical studies of "polywater" at Bell Telephone Laboratories. Evidence from electron spectroscopy (Science, *January 15, 1971*) as well as from earlier electron microprobe measurements, neutron activation analysis, X-ray milliprobe measurements, spark-source mass spectra, and scanning electron micrography all suggest, he said, that the "polywater" samples "are nothing more than mixtures of impurities with very little water present."

To clinch his argument, Dr. Rousseau showed infrared spectra of "polywater," sweat, and sodium lactate, the principal sweat constituent. All are reproducible, he said, and no one could doubt that all three looked quite alike. Dr. Rousseau readily admitted that "we have not been able to understand all the features of 'polywater.' But we have accounted for most of them," he said, and he and co-workers from Purdue University and the Hewlett-Packard Co. are satisfied that the foreign salts in "polywater" are responsible for the entire phenomenon.

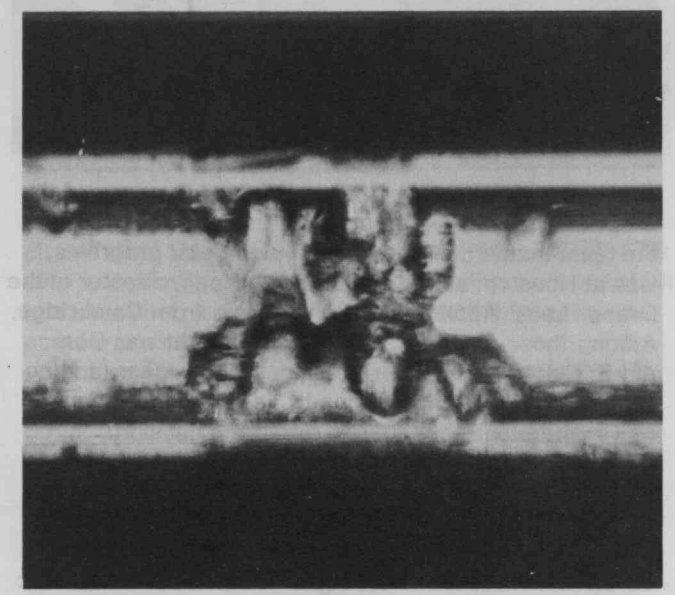
Dr. Rousseau and Dr. Brummer agree, however, that two features of anomalous water have yet to be fully explained: its temperature-phase response, which is so different from that of water, and its high surface tension. So the "noisy dialogue" may, after all, not yet be ended.

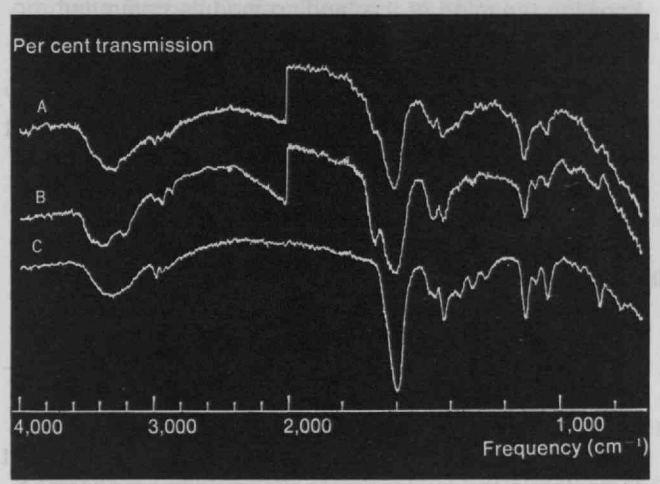
Twilight of the Engineers?

"During no 15-year period within the lifetime of any living man has there been so little engineering advance in housing." Professor Robert C. Juvinall, of the Mechanical Engineering department of the University of Michigan, is referring to the 15 years since the mid-fifties.

"Let us consider another example," he goes on, in a recent issue of *Engineering Education (February 1971, pp. 418-420).* "A typical upper-middle-class American high school senior cannot remember his family ever owning a car which differed very much, except for styling, from their new 1970 model. And he has never

Seeking to end "the noisy and unscientific dialogue" which has persisted for nearly a decade since Russian scientists first announced the discovery of "polywater," Denis L. Rousseau and his associates at Bell Telephone Laboratories have now published infrared spectra comparing their "polywater" (A in the chart) with samples of human sweat (B) and sodium lactate (C), one of its principal constituents. "Polywater" accumulates in small capillaries exposed to varying amounts of water vapor (top); though a few of its characteristics cannot yet be explained, Dr. Rousseau is convinced that "the presence of high concentrations of ionic impurities in such a complex mixture may account for many of the strange physical properties of 'polywater.'"





lived in a house without modern telephones, radio, and television."

Professor Juvinall chooses these examples to illustrate a "significant and disturbing point: Despite the accelerated increase in knowledge and pure technology, real engineering advances which have a direct and positive impact on the lives of people have been comparatively minimal during the past several years." (For a discussion of the nature of pure technology, see *Technology Review*, June 1970, pp. 38-45.) Professor Juvinall contrasts these latter years with the "Golden Age of Engineering," which he dates from 1868 to 1958—that is, from the coming of the railroads to the last major technical advance in civil transportation, the jet airliner. Other technologies—communications, household conveniences—made comparable strides during this 90-year period, but since then there has been very little technical change in the way people live.

In the Golden Age, "almost anything that an engineer *could* do, that was *profitable* to do, and that was *challenging* to do was also of real and direct benefit to society"—so there was little need to debate pros and cons. Today, "there are increasing instances where the end result of an engineering development is of questionable benefit to society."

Professor Juvinall does not believe, however, that the days of the engineer are numbered. He believes that the task has changed. Conventionally enough, he proposes that "the logical analytical approach of the engineer" should be applied to the determination of national priorities, and that—having discovered what these priorities are—"engineering effort must be applied in some general relationship to the importance and size of the jobs to be done."

A second Golden Age is yet possible, says Professor Juvinall. "Future society will be even more dependent upon the contributions of the engineer." But it will no longer be a matter of simply doing what is possible, profitable and interesting; it will be a matter of cooperating with other professions and with government in joint attacks upon mankind's major problems.

Shuttlebucks

The *Christian Science Monitor* has said that it may be "the last big space money of the century." Aerospace engineers generally assume that it will be built. A surprising proportion of intelligent, educated laymen seem never to have heard of it, in spite of its frequent exposure in the newspapers and on television. The Germans and the French believe that it is worth investing in; the British and the Dutch are awaiting a more convincing salespitch (*see* Technology Review *for February, 1971, p. 14*). It is the space shuttle, a stub-winged reusable manned ferry-ship plying between the United States and near-earth orbit.

The deputy director of N.A.S.A.'s Langley Research Center, Oran W. Nicks, speaking to M.I.T.'s Aeronautics and Astronautics Department on the coming decade's research opportunities, was asked about the economics of the shuttle. The goal is an order-of-magnitude reduction in the cost of transferring payloads to orbit, but, he said, it would probably take quite an extensive program of launches—many launches per year for about ten years—to recoup the investment on this basis. More important, to his mind, was a shift in thinking that had accompanied the development of shuttle plans. The shuttle was the first manned space project in which economics has had an important role in the design process. Mr. Nicks noted that this new philosophy was quite dif-

Involved in the Draper Lab's high-speed solution of Apollo 14's "faulty button" problem were (left to right) Bruce McCoy, Lawrence Berman, Samuel Drake, Peter Volante (standing), and Donald Eyles (who thought up the subterfuges).

ficult to apply, for lack of a background of hard data on the relative costs of different engineering approaches.

Cost-conscious space design is worthwhile not only for the direct economies it will produce, but also for its spin-off effects, Mr. Nicks believes. Hitherto, the application of space engineering in the civil world has been limited by its costliness. (Designers for whom money is no object will rarely hit on anything that will compete in the marketplace.) The shuttle effort is more likely to generate commercially competitive spin-off, said Mr. Nicks.

But even so, said one questioner, the taxpayers who will be asked to pay for the shuttle may not see the return on their investment for many years—not all of it, perhaps, even in their own lifetimes. Should not more attention be given to finding ways to boost the project's public-relations image? Mr. Nicks agreed that this was something to keep thinking about. But economic returns were not everything. Most people, in private conversation at least, would admit that there were values other than financial profit. The shuttle's public appeal should be to those nonmaterial values which "we tend to lose sight of in this American world."

Fooling the Computer

When the computer on board the Apollo 14 lunar module reported that it had received instructions to abort the mission—three and half hours before descent to the moon's surface was to begin, and before any such signal could mean anything—there were some who wondered if something was wrong with the computer. The "abort" instruction is ordinarily given by pushing a switch, and single switches are more reliable than whole computers. But the homely remedy of thumping the control panel removed the symptoms—temporarily—so it was indeed the switch that had failed.

The next question was whether the landing could be accomplished while this wayward switch was ordering abort procedures which would send the lunar module back into orbit. From Houston, the question went out to M.I.T.'s Draper Laboratories, where the computer programs for Apollo guidance and navigation are written, and where the flight was being followed by many of the programmers involved. Russell A. Larson, who manages the team that wrote the Apollo 14 computer programs, was at Houston, along with David G. Hoag, director of the Draper Labs' Apollo group, and others from Cambridge. Among those at the Draper Labs that night was Donald E. Eyles, who had written most of the lunar landing programs, and who was soon to find himself in the newspapers as the man who saved the mission.

In fact, Eyles was able, by drawing on his own unique knowledge of the landing programs, to devise a series of stratagems for circumventing the automatic procedures that follow an abort signal. To put it another way: knowing the mind of the landing-module computer, Eyles could think up ways to fool it.

The computer periodically examines a "mode register" in its memory to see what tasks are in hand. Eyles' first trick was for the astronauts to insert into this mode register the name of one of the abort programs, thus ensuring that if the computer received the spurious abort instruction it would be satisfied that the appropriate action was already being taken, even though no such thing was happening.

At the same time, the computer had to continue to control the descent. The mode-register alteration had resulted in a situation in which the computer (under the impression that it was *leaving* the moon) would neglect to switch in the guidance procedures required for a landing. So the astronauts had to be instructed to push buttons to bring in the landing guidance equations. Another task for them, at an early stage in the descent, was throttle control, which the computer would ordinarily have looked after—and which it was able to resume once the manual work-around procedure was done.

If at any time in the descent it had been genuinely necessary to abort, this could still have been done, by undoing the tangled web that Eyles had devised for deceiving the computer.

During and before an Apollo mission, the team at the Draper Laboratories is continually working on ways of tackling possible emergencies—"what-ifs," as they are called (*see, for example,* Technology Review, *June 1970, pp. 70-71*). And during the programming for the *next* Apollo mission, the search for possible mishaps focused on certain "critical bits," that is, yes-or-no signals that could cause trouble if the computer received them incorrectly. One of these critical bits, it was decided, was the one from the abort switch. A computer routine has been written for Apollo 15 which will, in future, take care of unwarranted abort signals. This was done about a month before Apollo 14, but it was of course too late to incorporate such a change into that mission itself. During Apollo 14, Houston did possess a plan of a kind for the same purpose, but one that would still have left the lander vulnerable to malfunctioning of the abort switch for a few seconds. The remarkable high-speed ingenuity of Donald Eyles, in contrast, provided a complete solution, albeit somewhat tortuous. The kind of re-programming it involved is not in itself unusual, but it has not previously been done so quickly.

Accepting a commendation from the Boston City Council two days later, Eyles said: "I hope it's understood by everyone that I'm here as a representative of a team." It is a characteristic of the Draper team that individuals acquire personal responsibility for specific parts of the output, and thus it was with Eyles.

So, if one other individual deserves particular credit in connection with the "abort" emergency, it is Bruce McCoy, who did what one colleague called "a tremendous job" of managing the team during those few hours—supervising the tests on the altered programs (which were run on the Draper Lab's simulator by M.I.T. graduate Samuel Drake), liaison with Houston, and advising on the final technical judgement that the problem had really been solved.

The Body Politic

A brand-new science has been launched—biopolitics. *Science News (Vol. 98, p. 434)* reports preliminary findings from a Munich meeting of the International Political Science Association and a meeting of the American Political Science Association in Los Angeles.

Biopolitics appears to have two main branches, one dealing with transient effects and the other with more or less sustained conditions. The former seems to be at a more advanced stage. Dr. John C. Wahlke (University of Iowa) and Dr. Milton G. Lodge (now at the Massachusetts Mental Health Center, Boston) have performed experimental work on transient biopolitical phenomena, by showing their subjects a variety of political symbols and slogans, asking them to express their approval or disapproval along a five-point scale, and noting at the same time any changes in pulse-rate, blood pressure and electrical skin conductance. (The latter parameters are accepted as indicators of emotional state.)

It was found that verbal responses did not always correspond with the readings on the dials: there were those who felt more strongly, or less strongly, than they said they did. So a person's avowed opinion on a political topic is not always a direct reflection of the reactions of his cardiovascular system and sweat glands. This discovery is said to add a new dimension to our understanding of political attitudes.

The less advanced branch of this discipline deals with the political effects of steady-state physiological conditions. Dr. David C. Schwartz, of the University of Pennsylvania, has received financial support for planned studies of the effects of aging, weight loss, general health, baldness, and other clinical observables upon a person's political principles. One difficulty is that of defining the political variables with adequate precision, but Dr. Schwartz hopes to have arrived at "significant understanding" of such effects within two or three years, "with the help of interdisciplinary teams."

The Uses of Trees

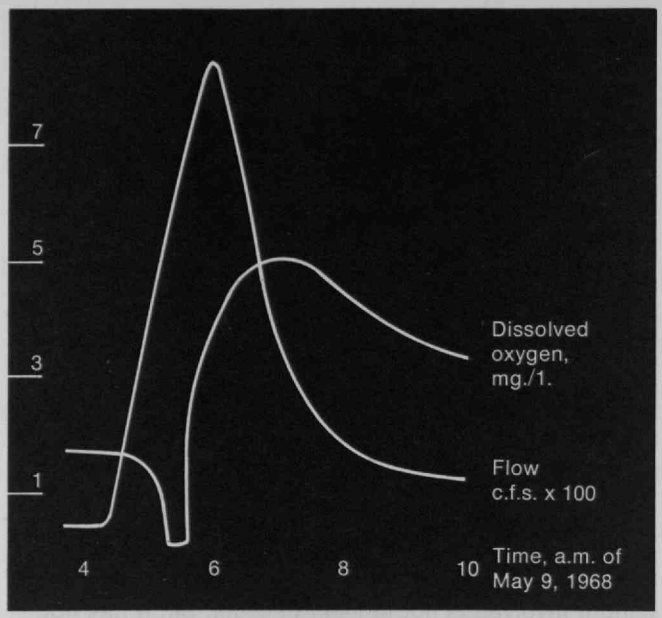
Conservation enthusiasts include among their bumper-stickers one that enquires "Have you thanked a green plant today?" Lest anyone should be so obtuse as to ask, For what? a paper presented to the American Association for the Advancement of Science by Dr. R. Keith Arnold, deputy chief of the Department of Agriculture's Forest Service, listed 21 uses for trees, of which supplying wood was the twenty-first. The first was "to screen displeasing or distracting views of dumps, airports, oncoming cars, or water tanks." Trees also muffle the sound of traffic, absorb radiant heat from walls and paving, hold the soil in place and protect it, and renew the human spirit.

Dr. Arnold became quite poetic (and why, indeed, not?); but when he turned to practical tasks of forest management his muse had to be restrained. "The toughest part," he said, "is to develop a value system for evaluating multiple outlets from forest lands. We need ways of comparing wood versus wildlife, range versus recreation, wilderness versus family camping." (Forest recreation is a multibillion-dollar-a-year industry, he noted.)

At present, decisions on how to change forests are made intuitively, for lack of real understanding of how forest systems work. (In another paper, Louis M. Glymph of the Department of Agriculture's Soil and Water Conservation Research Division told how water scarcities might be relieved by altering the vegetation of watersheds to cut down evapo-transpiration. Here, man's relation to the mountain greenery is clearly one of competition for a basic resource. The strategy of this battle is still a field for research.)

Dr. Arnold drew particular attention to one major move towards better understanding—the launching of the Pinchot Institute of Environmental Forestry Research, by the Forest Service and a number of universities. It is named after the turn-of-the-century conservationist who was "the moving force" behind the Service. Among the initial aims of the Institute will be "improving the quality of urban life by creating opportunities for recreation and esthetic enjoyment in a forest environment."

When a sudden spring thunderstorm flooded Jordan Creek in Springfield, Mo., in 1968, the creek's water quality went precipitously down—not from untreated waste in overburdened sanitary sewers but from the poor quality of run-off through the separate storm sewer system.



The urban tree, too, has many uses, at least one of which was not listed by Dr. Arnold. Purdue University's Professor F. O. Lanphear cited studies showing that trees could absorb limited amounts of industrial pollutants without being harmed. Douglas firs can absorb sulfur dioxide year after year, if its concentration does not rise above 0.25 p.p.m. If 5 per cent of the area of greater St. Louis were covered with these trees—50 million of them—they could theoretically absorb the entire local SO_2 emission, 445,000 tons a year. If the pollutant concentration rises too high, of course, the trees cease to cooperate.

The life of the city tree, indeed, is made precarious by many other stresses, to which few plants are really adapted. It is good news, therefore, that efforts are afoot to breed specifically for city life. Henry T. Skinner, director of the National Arboretum, noted particularly the rebreeding of the London plane, a hybrid sycamore which first appeared in 1670 by the crossing of Eurasian and American varieties.

Cleaning the Streets

A brisk summer thunderstorm crossed Springfield, Mo., just after dawn on May 9, 1968, briefly flooding streets and sharply increasing the flow of water in little Jordan Creek. Some storm water pressed into sanitary sewers, and in the emergency some untreated waste was discharged into Jordan Creek. A common story.

But it has a different ending, because Bruce R. Barrett of the Robert S. Kerr Water Research Center was in town to survey water quality following occasional—and unexplained—fish kills in streams below Jordan Creek.

As he watched on May 9, Mr. Barrett saw Jordan Creek swell from trickle to flood and turn from clear water to black slurry. Later his monitors showed that Jordan Creek's dissolved oxygen had quickly dropped to 0.6 mg./l., while its biological oxygen demand (B.O.D.) rose to 149 mg./l., its chemical oxygen demand to 408 mg./l., its suspended solids to 383 mg./l., and its oil and grease content to 31.9 mg./l.

The monitors quickly proved that the problem came less from sewers than from streets; Mr. Barrett's evidence confirmed what other studies have shown elsewhere: the poor quality of urban run-off, writes Mr. Barrett in *Civil Engineering (January, pp. 40-42),* is now becoming recognized as a special sanitary problem. Street refuse, oil, disintegrated asphalt, animal droppings, stagnant water from catch basins, and chemicals from many sources—all are swept up in storm sewers, for whose water no treatment before discharge is the standard treatment everywhere.

Given a Muffler, How to Sell It?

Michael Paczkowski has a problem. He has invented what he believes is an effective pollution control device for the reduction of automobile exhaust emissions.

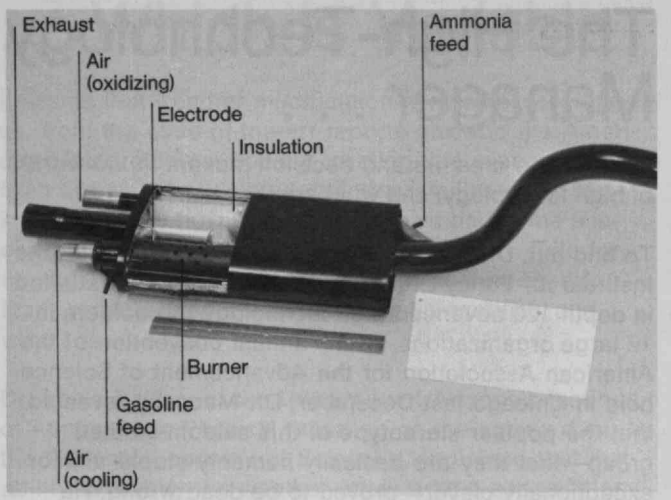
Actually, the "problem" is being shared by Innova, Inc., a Seattle-based technical intermediary firm which is searching for a source of venture capital for the further evaluation and eventual manufacturing of the device.

The invention itself is a replacement, at about twice the cost, for the standard automobile muffler. Empirical first tests show that it may remove up to 90 per cent of the nitrogen oxides from the exhaust.

Called the Nanaimo System, the gadget differs from the old muffler mainly by the addition of two air induction hoses and a bottle of ammonia. The first air hose feeds a gas-fired afterburner which creates temperatures of 1,700° to 1,900°F. in the main chamber, where partial oxidation of carbon-based contaminants takes place. The other hose, bringing the reagent ammonia with it, effects the turbulence and cooling necessary for the near completion of the reaction ($NO_x + NH_3 \rightarrow N_2 + H_2O + e$).

In operation, the device will increase gas consumption by 2 to 3 per cent, but its inventor claims an increase of horsepower to the rear wheels by 8 per cent; it can be installed without engine modification. Other factors,

Michael Paczkowski of Seattle, inventor of this reactor to substitute for an automobile muffler and clean its exhaust, claims it can remove up to 90 per cent of the nitrogen oxides through an oxidation with ammonia. But "selling" it in Detroit and Washington is harder.



such as operation at different acceleration modes, hazard evaluation, optimization of thermal and chemical kinetics, and durability, need further testing.

But the technical aspects of the development are rather straightforward compared to the fancy footwork with politicians and businessmen that must precede the appearance of the Nanaimo System as a commercial reality. This is the "problem", as described by Gary Lewis, Vice-President of Innova.

First, pending legislation would require high standards of emission control only of cars made after 1975. By 1980, this law would cover just 50 per cent of the automobile population. However, if the legislation could be made applicable to all cars, then 80 to 90 per cent of the population would be "clean" in a few years and, not incidentally, the market for the Nanaimo System would be greatly increased. So there is a brisk exchange between Innova and several Senate offices.

With regard to the full-scale manufacturing of the device, it has been hard to interest Detroit. New-car makers are not enthusiastic about things to improve their old products, and in any event they are leaning toward basic engine modifications to meet the coming pollution standards. Other potential manufacturers are being contacted, but nothing is definite yet.

Building a better mousetrap is simply not enough. Most inventors must also make the cheese and bring in a few rats.—*William Osinski*

May His Tribe Increase

"Family planning" is a euphemism, left over from the days when euphemisms for birth control were needed. Its continued use is regrettable, thinks Bertram M. Gross, Director of Urban Affairs at Hunter College, New York, since it "carries misleading (although propagandistically useful) connotations of concern with family welfare beyond the number and spacing of children." In fact, Professor Gross notes, "so-called family planning organizations are not conspicuous in their direct concern for much broader questions relating to the quality of family life."

Hardly anyone is. There is a general neglect of "the powerful factors making for family fragmentation in American society." The industrial revolution was accompanied by the breakdown of the old extended family, leaving only the "nuclear" family, which is now being disintegrated in its turn.

And yet the family has its uses: "a refuge from bureaucracy, a provider of emotional security and mutual self-help, the major educational institution in the country . . ." (Rep. John W. Davis, the new Chairman of the Science, Research and Development Subcommittee of the House Science and Astronautics Committee, said in another session that one of his major sources of science news was his own children, and recommended this route—among others—for the education of the whole adult population).

The family alone can deal with those "nonuniform problems" that bureaucratic systems cannot tackle, said Professor Gross. So a positive attempt should be made to preserve it against the forces of its destruction.

Could the invigoration of family life become an objective of public policy, he asked? The first requirement would be to really find out what is wrong and right with American family life. (He suspects that the well-known fragmentation of the black family may turn out have its counterpart—"at least as widespread, if not more so"—among the rest of the population.) Second, many of the social programs we now have would need to be reoriented: to take a simple example, "housing and community facilities that are specifically designed to provide environments more conducive to enlarged and healthier family life."

What Professor Gross calls "old-fashioned 'family planning' " would have its place in such a drive, but its overall purpose would be "to provide people with more options, as a matter of human rights rather than population policy."

The High-Technology Manager . . .

Who *are* the creators and decision makers in the world of high technology, and what are they like?

To find out, Dr. Michael Maccoby, Visiting Fellow at the Institute for Policy Studies in Washington, D.C., studied in depth 120 advanced high-technology job holders in 12 large organizations. At the annual convention of the American Association for the Advancement of Science held in Chicago last December, Dr. Maccoby revealed that the popular stereotype of this seldom-studied group—that they are basically humanly stupid and/or exceptionally clever—proved to be dead wrong. He found them less hostile and more open to reality than the average university professor.

Among the high-technology decision makers, there are no robots or emotionally dead men; many are very sensitive to the feelings of others. They seek the highest good for the full development of themselves and their organizations—though the notion that they see these two "goods" as the same was not borne out.

These men are concerned for efficiency, but open to experiment and flexible; self-confident and aggressive, but cooperative; highly competitive, they nevertheless play by the rules—the "football paradigm of professional character." But modesty, loyalty, idealism and compassion, the high-technology manager recognizes as being traits professionally least important to him—and he is troubled by this.

The industrial high-technology managers generally dislike military assignments; their primary concern is for the marketability of their product. Dr. Maccoby detected a new concern on the highest levels about the social consequences of new technology, and a growing worry over whether or not young people would join them in their enterprises. On the other hand, he did not uncover a single instance of rejection of a piece of technology on the grounds of social danger.

Do these men believe that technology can solve the problems of mankind? There was no consensus, but there was a widespread feeling, Dr. Maccoby said, that technology can solve few of man's problems without changes in society. In other words: society must change to suit the kinds of solutions technology can offer.

. . . the People

How does the man in the street conceive of technology, and what are his feelings and opinions about it?

In a Boston-area survey conducted by Harvard University's Program on Technology and Society, more than 50 per cent of the respondents defined technology as "ways of doing or thinking." The remainder used objects, like the computer, as their definition.

In this small-scale pilot public-opinion survey conducted on a meticulously chosen cross-section population, it appeared that occupation and education accounted for the primary variables in people's attitudes towards technology. Managerial types have the most positive attitude. Skilled workers have a less positive attitude, but not to the point of being anti-technology; sales and service personnel fall between. The less knowledgeable a person (measured in this instance by years of schooling) the more critical he is of technology—an indication, says Irene Tavis of Harvard's Technology and Society program, more of social alienation than of anti-technology convictions; however this group did not see technology as a direct cause of their alienation. She describes the pro-technology people as "main stream" members of society.

While some notable exceptions to this conclusion come readily to mind, the survey results do clearly show that the more extensive the schooling, the more positive the attitude towards technology. This prompts speculation that our schools are teaching pro-technology attitudes as a social value (and indeed, right or wrong, a positive public attitude toward technology now seems necessary to keep our economy from floundering). Only 7 per cent of the survey population felt that "technology" does more harm than good.

Age counts, as well as education. The anti-technology skilled and semi-skilled people tend to be from 50 to 70 years old, and the college-educated from 19 to 29.

There was a certain amount of ambiguity to be found among public attitudes. Ninety-four per cent agreed that technology makes life easier, but three-quarters believed that the quality of life in the country excels the quality of life in urban centers. A large majority says that TV makes people "more aware," but 73 per cent argue that people are too dependent on machines. More than 90 per cent agreed that technology increases efficiency, but 73 per cent feel they have been reduced to punched-holes in a card.

The public is concerned about invasion of privacy. Sixty per cent agree that credit bureaus, for example, should know little about people. They are not concerned about the knowledge the government now has of them, but 54 per cent are opposed to the National Data Bank.

Asked to rank government programs by priority, the public placed social welfare programs at the top of their list, technical programs at the bottom. The highest priority went to welfare and poverty programs, followed by mental health, urban housing, and pollution. Three-quarters said that they were worried about pollution and were willing to make some sacrifices for its abatement. On the other hand, 84 per cent thought that industry should pay, without passing the cost on to the consumer. Showing some discrimination of technological taste, the majority favored genetic research and fluoridation, but opposed the A.B.M. and S.S.T. At the very bottom of the priority scale for government programs came defense and space, in that order. More than 60 per cent believe that there is a military/industrial complex, but many couldn't define the concept.

Who would make the decisions about these technical programs? Generally the people questioned found little fault with the present assignment of responsibilities, although there was a definite trend toward wanting more direct citizen voting. The well-schooled believe that the President should make fewer of these decisions; the less schooled, that Congress should make fewer. "Experts" enjoy high esteem, and this sample population would give them a more powerful say in the allocation of funds for scientific research and technical programs.

And what of science? Most saw this breeder of technology as good in itself, but complained that "it makes life change too fast"—an interesting belief in view of the observations of Professor Juvinall of Michigan (*see page 65).*

. . . and the Weather

Dr. J. Eugene Haas, a sociologist from the University of Colorado, presented to the American Meteorological Society at its meeting in San Francisco some general conclusions about the relationship between those who modify the weather and those whose weather is modified. He conducted interviews over the first year of an experiment in three rural areas—New York, Montana, and Utah—both in towns that would be affected and in control towns that would not.

Which town of the pair a person lived in made no difference to whether or not he approved. Those people in the professions or in managerial positions, those of more education and fewer years, and those active in politics were most apt to approve of modification. Approval for the specific program being done rose slightly over the course of the year; but approval of weather modification in general decreased. The only area where protest developed was the one that showed the greatest rise in acceptance. (The protest was organized by operators of ski resorts around the New York area.)

Most of the people interviewed (85 per cent) agreed on one point: that the decision to modify the weather should be made by local residents or local public officials. Only 4 per cent entrusted the decision to scientists, and 10 per cent to more distant governments. (Dr. Haas added that other attitudes investigated did not indicate an anti-science bias.)

But in fact, what has been done to date has usually been decided unilaterally by those who did it—and very few protests have developed.

Dr. Haas pointed out that no regulated process yet exists to govern such decisions. Some mechanism will be set up, he feels, and he listed some questions it should take into account: Which available methods are economically feasible for what areas? What social, legal, and ecological criteria shall be used when evaluating the effects? How should damage claims be handled? How should the costs of modification be shared?

And perhaps the most important one of all: Who should have the last word on whether or not to modify?

. . . Which Is Variable

It seems that weather modification is more or less upon us, from the state-of-the-art reports given to the American Meteorological Society meeting this winter, and from the warnings uttered. It is the familiar story: we know basically how to do it, and we've had some success, but we are far less sure about what it will do for us, or to us. And there is presently no agency specifically responsible for control over who modifies, and why, and when.

Dr. Louis Battan, of the University of Arizona's Institute of Atmospheric Physics, reporting on the survey done by the National Academy of Sciences, explained that our ability to modify the weather came a little sooner than we expected—we now find ourselves able to stimulate rainfall from clouds with some degree of precision. Hurricanes Debbie (*see* Technology Review, *February, 1970, p. 63*) and Camille were both, it is claimed, effectively seeded, slowing down their winds.

Thus, we will probably find that we can suppress hail, lightning, and fog, and even influence the winds and direction of hurricanes—some of this within a few years. What will be done, of course, will be done for the ease of man, for his safety or for his agriculture. Dr. Charles Cooper, of the National Science Foundation, points out that ecosystems differ in their responses to changes in the weather. The agricultural ones, that have only one or two plants in residence, are highly managed, and are affected for good or bad each year—one year the corn or the grapes are plump and sweet; another, few and spare. Natural systems, conversely, are affected little from year to year, but a small climatic trend over many years—perhaps one degree of temperature more or less—will eventually result in radical changes. Since modification will be done to benefit the former, we had best take care for the latter.

Weather modification shares with other areas of meteorology a vast degree of uncertainty. The contributing causes are so diverse as to make analysis, or even delineation, of the effects extremely difficult. One would like to know how modification of the weather in one area will affect another area two hundred miles away; but the answer will be subject to the same hazards as is weather forecasting in general.

Dr. Robert White, Acting Administrator of the National Oceanic and Atmospheric Administration (N.O.A.A.), describes the regulation of weather modification at present as a "hodge-podge." There is no federal control. Some states have laws, some states are favorable, some are opposed. He recommends that the regulation be federal, recognizing that weather follows its own paths, not state lines. Intelligent controls might, he said, "provide a focus for constructive, intelligent effort" and convince the states "that somebody in Washington is, after all, trying to protect their interests." He added that "we must regard the poorly informed citizen as a client, not an adversary." Some participation in weather-modification decisions by the citizenry seemed to be favored by the A.M.S. group as a whole.

Sewage Oyster-Farm

Using secondary sewage for nutrients, a natural recycling process can produce, ultimately, oysters on the half-shell. Experiments with controlled variations of this process could provide information which could help solve current problems of sewage disposal, food production and coastal-zone uses.

John H. Ryther, a marine biologist at Woods Hole Oceanographic Institution, has set up a model of a sewage-to-shellfish system; he finds that theoretically the sewage that 11,000 people produce could fertilize 50 acres of algae, cultivated three feet deep, which could then be food for oysters under cultivation in a one-acre, 30-foot salt pond. Two or three years after its establishment, the system could yield 1 million pounds of meat per year while providing tertiary sewage treatment for 11,000 people. The coastal waters that the system occupied would be clearly defined, leaving adjacent waters unaffected and free for other uses.

Eutrophication, in the correct usage of this popular word, is high biological productivity resulting from a balanced high availability of essential nutrients. The 10 per cent of the world's oceans in which this condition occurs are the areas from which almost all food from the sea comes. But *abnormal* eutrophication—an overload of plant nutrients (commonly abbreviated to "eutrophication")—can result, for example, from releasing untreated or secondary-treated sewage directly into the sea. This process is slowly killing the shallow, productive coastal waters. Sewage-aquaculture systems could help reverse this process, by fencing off the extra plant nutrients and putting them to work.

The experimental system at W.H.O.I. uses a nutrient solution of 5 to 10 per cent secondary-treated sewage in seawater for cultivating algae. In the laboratory, under artificial illumination and controlled temperatures, the mix of algal life resembles, both in the abundance and the diversity of the diatoms, that of untreated seawater. Its algal cell density, however, has regularly been 1,000 times greater.

After it has been diluted to nutrient levels below those of natural, unpolluted seawater, the solution flows through a bank of trays in which lie dense cultures of juvenile American oysters. The oysters, which are usually over an inch in diameter when they arrive from a West Coast hatchery, completely strip the solution of nutrients.

Gratified by this success in the laboratory, Dr. Ryther plans to cultivate the algae outdoors this summer. The oysters will go from the laboratory trays into deeper, outdoor holding tanks. Here the two- to three-inch oysters will be suspended on strings from cross boards as they would be in the established raft culture technique. He hopes to raise these oysters to their maturity, which could be as soon as late summer 1972.

Dr. Ryther and his colleagues would now like to experiment with this basic system, varying the types of treated sewage and using other natural and cultivated algae and other species of molluscs—mussels, hard clams, and bay scallops. He anticipates that this work could be of value in solving larger environmental problems.

He emphasizes, however, that this system's ultimate usefulness can only be assessed completely after it has been scaled up in its intended environment. He proposes a pilot-scale laboratory which could be part of W.H.O.I.'s recently acquired Quissett Campus. It could also serve as a laboratory base for all other kinds of coastal environmental experiments. Scientists and students from M.I.T. are working at W.H.O.I. under the joint-degree program established in 1969. They could be the nucleus, Dr. Ryther suggests, of a program which would expand to include more formal arrangements with Harvard and Yale, with whom now only informal agreements exist.—*Lucy Sloan*

S.S.T.: Can Technology Assessment Be Divine?

Amidst the cacophonous debate on the merits of the U.S. supersonic transport in which the distinctions between technology, science (right, wrong, unknown, or perhaps unknowable), economics and politics became almost irretrievably confused, the engineer's position was most clearly taken by the American Institute of Aeronautics and Astronautics. After bringing together a group of special-

ists from its membership, A.I.A.A. concluded early in March that "current plans advanced by the Department of Transportation for the (S.S.T.) prototype program are reasonable and proper and in the best interests of this nation."

The arguments about proceeding to the prototype stage – and then, perhaps, to commercial production – of the 1800-m.p.h. U.S. aircraft centered in four issues: technological feasibility, noise, environmental effects, and economics.

Of the four, technological feasibility is the easiest with which to deal. The A.I.A.A.'s calculations placed the aerodynamic efficiency – the product of the craft's flight speed and lift/drag ratio – at about 20, compared with about 15 for all subsonic jets and 16 for the Concorde. The structural efficiency – ratio of maximum take-off weight to empty operating weight – of the S.S.T. prototype was to be just over 2.25; the 747 is 2.02, the Concorde 2.24, and that of the production S.S.T. as high as 2.50, depending on new joining techniques and exotic materials which were possible but not yet assured. The current performance indicators for the engine designed for the S.S.T. "are already estimated to be 10 percent better than those of the Bristol/Olympus engine which powers the Concorde," said the A.I.A.A. assessment.

In short, the conclusion was that "the current design status of the B-2707 production aircraft indicates its capability to meet all present performance specifications."

What about noise? The S.S.T.'s sonic boom is a fact of life, and A.I.A.A. joined the plane's harshest critics in accepting the Federal Aviation Authority's ban on overland supersonic flight; an exception was possible for remote areas of the Arctic. Will sonic boom be an environmental hazard at sea? Probably not, though no one can be sure. Water is a better reflector than conductor of mechanical energy; and "the natural deep-ocean environment is a rugged one, with natural forces far greater than those characteristic of a sonic boom," the A.I.A.A. report said.

S.S.T. engine noise is a far different and more complex problem. A recent resolution of the U.S. Senate limits future aircraft engine noise in airport neighborhoods at take-off and landing to levels lower than those of current 707's and 747's, and no one expected the prototype S.S.T., which Congress was asked to authorize, to meet that requirement.

But new developments would have been ready for the production models of the S.S.T.: the engine could have been larger in physical size, making use of afterburners unnecessary during take-off and permitting more effective new noise suppression. As a consequence, said the A.I.A.A., the production S.S.T. "can be expected to meet (or better) the Senate-stipulated engine noise limitations." (This judgment seems to conflict with that of Laurence I. Moss of the National Academy of Engineering, who was quoted in *Technology Review* for January *(p. 72);* Department of Transportation and Boeing officials emphasize to the *Review* the difference between the prototype S.S.T., whose design is too far advanced to

permit use of the new-dimension engines, and the plans for production models.)

The S.S.T. would be flown in the stratosphere, far higher than any commercial jets have flown heretofore. Could its pollutants collect in this zone of relative stability to eventually cause changes in weather or climate? In an article scheduled for publication in *Technology Review* next month, George D. Robinson of the Center for the Environment and Man, Inc., paraphrases the conclusion of the 1970 M.I.T. Study of Critical Environmental Problems (S.C.E.P.): "It is not possible to say what the ultimate effect (of a commercial S.S.T. fleet) on climate and weather might be, but . . . there is an imminent prospect of a measurable environmental change."

The A.I.A.A. agreed: "Our knowledge of the composition and dynamics of the stratosphere is at present not adequate to provide definitive answers to all the possible environmental questions. . . ." But this was not considered an argument against the prototype S.S.T.; indeed, said A.I.A.A., data obtained in prototype flights "will be an important element in the investigation" which everyone recommends. In any event, "it can be stated with full confidence that flight operations of the two prototype S.S.T.'s will not cause any equilibrium changes in the environment," the A.I.A.A. report added.

John M. Swihart, Boeing's chief engineer for S.S.T. production, reported that Boeing's own studies revealed "no basis for any claims (of potential environmental damage)." ("However," he added, "in some cases more data is required to show there is no effect.") Boeing publicity which proposed categorically that "the S.S.T. will have no appreciable effect on the atmosphere" was an assertion which could in no sense raise the quality of the debate.

. . . And Unemotional?

A gentleman sat at the lunch counter in Washington's National Airport – a gentleman from Seattle. "Sure, I'm as worried as anybody about the environment, but it's just inevitable. It's gonna come. I run a plant out there. A month ago we put a 75-cent ad in the paper for a laborer – 85 guys showed up. $1.75 an hour. This guy got it because he was persistent, but he can't do the job. I feel sorry for him – a Ph.D. for a buck seventy-five."

The debate about the S.S.T. spread through many layers – the issues were of politics and economics as well as of ecology and technology. Crossing all of these layers were the emotional pleas: for American prestige, for job security, for a certain reverence for the spaceship earth, for the control by men of a feared technological juggernaut.

Arthur Okun, former Chairman of the Council of Economic Advisors, told Congress that he had yet to see an independent economist support the S.S.T. (He admitted he did, as a public official.) Paul Samuelson, Nobel Laureate and Professor of Economics at M.I.T., took a position consistent with Dr. Okun's observation: "We are faced here with a colossal economic folly. In this day, there is no excuse for pyramid-building to make work and to add to the nation's spurious glory . . . Any realistic cost-benefit analysis will reach the conclusion that at every stage in the history of this project, non-political commissions have arrived: namely, that government subsidy of the S.S.T. or similar supersonic aircraft is at this stage of technology and economic development both an economic and human disaster."

Some economists espoused the S.S.T. to redress a grievous balance of payments; a *New York Times* analyst suggested that the increased tourism supposed to result would send more dollars abroad than the S.S.T. sales would bring in. The A.I.A.A. *(see above)* concluded that the government's $1.3 billion investment in two prototype aircraft would return $6.5 billion in taxes, were the fleet produced, including the taxes of 200,000 workers directly employed on the S.S.T. The S.S.T.'s productivity – passenger miles per year – was estimated by the A.I.A.A. to be 75 per cent greater than the 747's and also greater than that of the Concorde or TU-144. But *Aviation Week* has said that government financing – perhaps $1 to $4 billion worth – might be needed to build the fleet. Few critics spoke specifically of the S.S.T.'s prodigious fuel consumption, but that was surely a factor in both economic and environmental arguments.

Two S.S.T. prototypes might have answered many questions: What payload would the production plane have while meeting airport noise limits, what would be its potential for altering the stratosphere – and perhaps the earth's climate, what would the production fleet really cost to build?

But they could not have answered many others. Is there a groundswell rising of public desire to get to Paris by noon or Bangkok by three? Would the Russians and Europeans be permitted to monopolize a part of a market we consider ours? Was the defeat of the S.S.T. prototype program necessary to reassure those who fear technology-out-of-control, or was its funding necessary to reassure those who fear that we may lose our control over our world if we turn away from technology? Perhaps we don't need to be first and best in everything? Does building a prototype perforce build such momentum that the production program cannot but follow? And could the money be spent to better purpose – a sum considerably larger than that spent recently for urban transit or for unnumbered social programs? Is it necessary for a federal official, as one did, to tell a large group of aviation people that an outspoken opponent of the S.S.T., a reputable scientist, has a psychiatric problem?

Perhaps it should not be so surprising that emotionalism is so large a part of a debate on technology assessment. We are reminded that, after all, engineering is an inexact science. The real question may be one that the debate largely neglected: Is there any way short of the $1.3 billion prototype program to answer the legitimate scientific, technological, and economic questions which are so largely lost in the rhetoric of the political arena?

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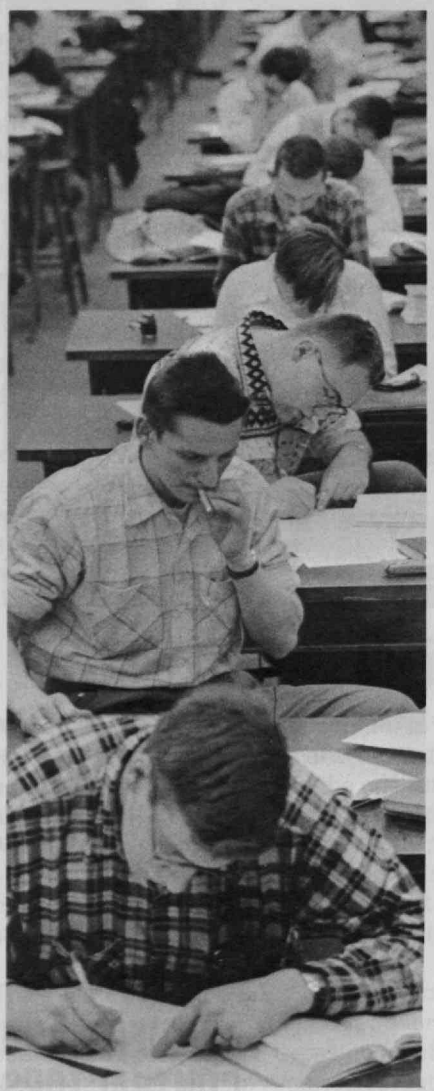


Among the strains institutions of higher education must grapple with today is the large increase in the number of young people they must educate. The Chronicle of Higher Education *has recently reported that the percentage of young persons in the population with four years of college or more has nearly tripled in the past 30 years, going from 5.8 per cent in 1940 to 16.4 per cent in 1970. During the same period, the percentage of persons with four years of high school or more rose from 37.8 per cent to 75.4 per cent. (Photo: Gjon Mili from* Life)

New Look at Old Goals

Learning is the first purpose of colleges and universities. When the chips are down, research and public service must take second place, and the flexibility and quality of education must ever be improved.

Nine themes and 85 theses in the first report of the American Academy of Arts and Sciences' Assembly on University Goals and Governance, published this winter, build on this elementary proposition. As U.S. higher education has become increasingly popular, serving ever-larger numbers of the population, it has sometimes lost sight of this goal; it has inadequate knowledge of education and its effects to yield the improvements that are needed; its diversity is eroding; and quality is in jeopardy.

Indeed, says the Assembly report, "every innovation that reduces the pressure on colleges and universities to accommodate all, including those who are not interested or able—and that reinforces an element of choice on the part of the individual—is desirable." We need "alternative paths to intellectual and professional development," says the report.

Among the Assembly's 85 (sometimes apparently contradictory) theses designed to stimulate discussion of change and reform, a few have special relevance to education centered in science and engineering:

◇ "Students ought to be permitted to intermingle study and work in ways that are now uncommon. . . . (This) is an assertion that significant employment opportunities for students may be provided in term-time if the university recognizes the value of such experience and is prepared to admit its educational importance."

◇ "National and institutional examinations should be further developed to enable students who lack a bachelor's degree to go directly into advanced graduate or professional study."

◇ "The most stimulating university teaching generally occurs where the individual is actively engaged in significant scholarly research or in other creative exploration. . . . Any attempt to develop a teaching ethic in higher education that would banish research would risk making teaching sterile."

◇ "Colleges are not very successful in communicating the nature of scientific endeavor or inquiry to those—the great majority—who do not concentrate in the natural sciences. . . . So long as the majority of American students situate themselves in nonscientific disciplines, there is an obligation to instruct them in the activity that dominates contemporary culture and yet remains so alien. . . . Too many colleges and universities have accepted for too long the reality of their students' scientific illiteracy."

◇ "An undergraduate's decision to concentrate in a given field ought not to

be taken to mean that a new recruit has been won for graduate study in that field . . . "

◊ "Certain large institutions might experiment with creating programs that permit early specialization. For some beginning undergraduates, a university option with immediate entry into advanced professional or academic study should be made available."

◊ "With the American penchant for 'professions,' each decade sees more occupations so labeled. Professional schools in colleges and universities often work hand in hand with professional organizations to set up qualifications—and restrictions—for entry into their fields. . . . The role of colleges and universities as gatekeeper, granting 'passports to employ' to professions and callings, is onerous." Education, not certification, should be the goal.

◊ "An early preoccupation with a narrow vocational competence is gradually giving way, at least in some universities (in certain professional schools more than others) to a greater concern with research and theory. This tendency carries desirable possibilities . . ."

◊ "Research in universities, whatever its source of support, ought not to be secret."

◊ "There is no reason for universities to serve as holding companies for large laboratories or research projects that are not linked to their educational programs."

◊ "Private institutions ought to continue to exist as sources of experimentation. The major private institutions are important precisely because they guarantee that higher education is not pushed toward uniformity and political hypersensitivity."

The Assembly report was written largely by its Chairman, Martin Meyerson, President of the University of Pennsylvania. In addition to staff assistance, Dr. Meyerson had support from five Assembly councils—on learning, scale and quality, research and service, institutional relations, and governance. Three members of the M.I.T. faculty—Noam Chomsky, Professor of Linguistics; Walter A. Rosenblith, Associate Provost; and Steven Weinberg, Professor of Physics—were among an advisory panel of members of the American Academy of Arts and Sciences.

The Searchlight of Mathematics

Paul A. Samuelson, Professor of Economics at M.I.T., said he was instructed that his Nobel Lecture to the Swedish Academy must be a "serious" one; it was—but sparked by the cutting wit for which he has won fame in Cambridge.

The lecture on "Maximum Principles in Analytical Economics" provided a summary of Professor Samuelson's 30-year career as an economist surrounded at M.I.T. by scientists and engineers: "The scientist who formulates the laws of observed empirical phenomena is essentially an economist or economizer. . . . Often the physicist gets a better, more economical description of nature if he is able to formulate the observed laws by a maximum principle," Professor Samuelson said. Similarly, he said, "the economist is able to get a better, more economical description of economic behavior from the same device."

Transferring the least-time principle from physics to economics, Professor Samuelson first considered the problem of an entrepreneur whose output is producible by two, three, or 99 different inputs. It is only common sense that raising any single input's price will reduce the firm's demand for that input. But what about the effect of an increase in the price of potatoes

When he returned from Sweden, where he received the 1970 Nobel Prize in economics from King Gustav VI Adolf on December 10, Professor Paul A. Samuelson said he would surprise his regular Newsweek *readers by rating the quality of life in Scandinavia as "appealing."*

"Had it not existed, the world would have had to invent Sweden," he wrote—"where government plays a major role yet plays remains handmaiden of the people." Meanwhile, E. Cary Brown, Head of the Department of Economics at M.I.T., was describing Professor Samuelson's work as providing "a unifying field theory for all economics;" and Francis E. Wylie, M.I.T.'s retired Director of Public Relations, wrote in Finance *magazine that Professor Samuelson is "the St. Paul in the elucidation of the Keynesian gospel." (Photo: United Press International)*

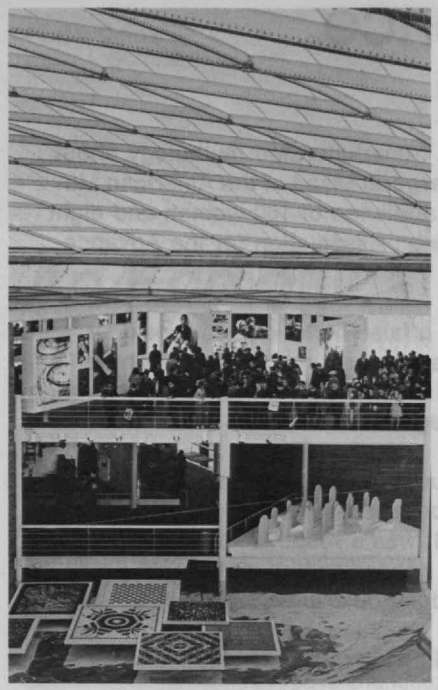
on Irish farmers, who must depend heavily on potatoes when they are poor? The new price "may itself impoverish them so as to force them into buying more rather than less potatoes." In this case, he said, "common sense recognizes itself only under the searchlight of mathematics."

Advancing into thermodynamics, Professor Samuelson considered a formulation of what is known in physics as LeChatelier's Principle: "Squeeze a balloon and its volume will contract. But compare how its volume contracts under two different experimental conditions: First, imagine that its surface is insulated from the rest of the world so that none of the so-called heat engendered can escape. In the second alternative administer the same increase in pressure in the balloon, but let it come into temperature equilibrium with the unchanged temperature of the room. Then the increase in volume will be less than when the temperature is constrained to end up constant."

If you look at the same firm with 99 inputs, said Professor Samuelson, "you can connect up its structural relations with those that prevail for an entropy-maximizing thermodynamic system. Pressure and volume, and for that matter absolute temperature and entropy, have to each other the same conjugate or dualistic relation that the wage rate has to labor or the land rent has to acres of land."

Finally, Professor Samuelson reached the mechanics of vibrations: "A glance through modern journals and texts will show that, whereas the student of classical mechanics deals often with vibrations around an equilibrium, as in the case of a pendulum, the student of economics deals more often with motions around a saddlepoint of catenary shape; just as a rope suspended between two nails will hang in the shape of a catenary, leaning toward the ground level, so will the economic motions hang in the shape of a catenary toward the turnpike."

Why "turnpike"? "All Americans are used to the notion that . . . the fastest way (to go from one point to another) is to move quickly to a major highway and only at the end of your voyage depart to your local goal. So in economics: to develop a country most efficiently, . . . it should proceed rather quickly toward the configuration of maximum balanced growth, catch a ride so to speak on this fast turnpike, and then at the end of the 20-year plan move off to its final goal. An interesting triple limit is involved: as the horizon becomes *large,* the distance from the turnpike becomes *small* in which you spend an indefinitely *large* fraction of your time."



Was the U.S. pavilion at Expo '70 (above) the prototype for a new form of campus architecture? Such a vast, unsupported space shielded from the weather under an air-support structure would make possible a campus freed from structural constraints, says Bernard P. Spring of Davis, Brody and Associates—an architecture (below) which would, of itself, inevitably break down the walls that too often separate the academic disciplines. (Osaka photo: Shunk-Kender)

A Truly Spacious Campus

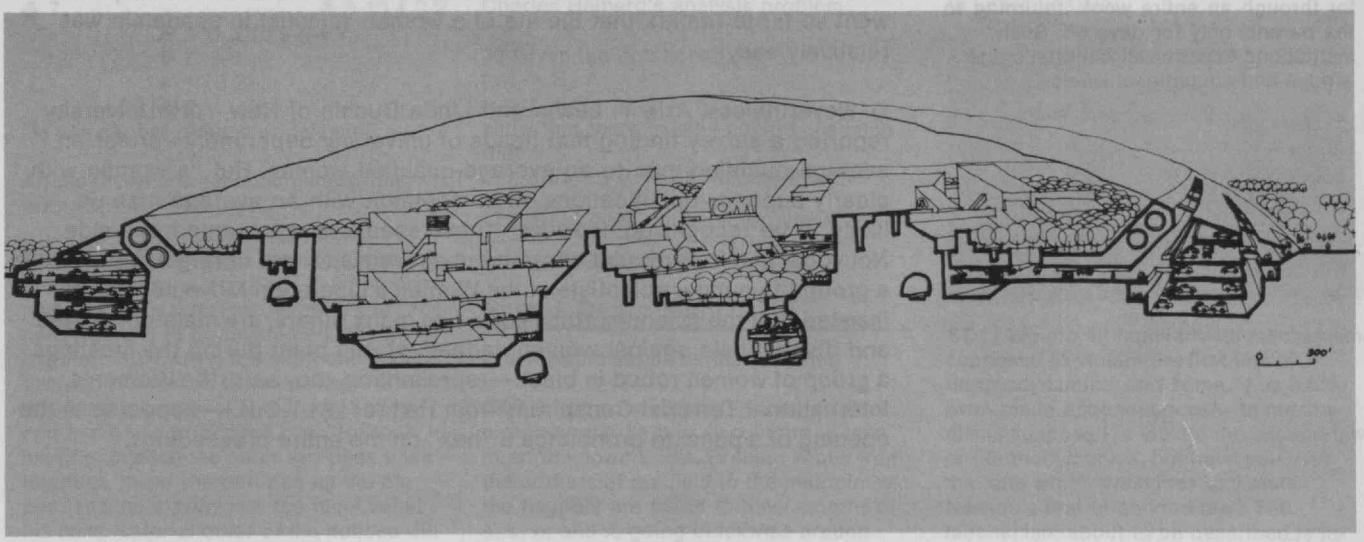
A new type of academic architecture is now being proposed by Davis, Brody and Associates, New York architects, on the basis of experience with the United States pavilion at the Osaka World's Fair. Indeed, the dream of a whole city—or, in this case, an entire campus—enclosed in its own special environment under a great transparent tent may in fact be near reality.

The U.S. pavilion at Expo '70 was such a space, 120,000 sq. ft.—nearly three acres—without interior supports of any kind, carried entirely by a slight differential in air pressure constantly maintained between inside and outside—a low-pressure hemispheric balloon fastened to the ground along its open circumference.

Now Antioch College has announced a plan to create its campus in the new community of Columbia, Md., under such a structure. Antioch's will be small by Osaka standards: 210 ft. square, 35 ft. high; and it will be stabilized by vertical supports, a system developed by Goodyear Tire and Rubber Co. In it will be a variety of small, simple classroom and laboratory structures which will require neither weatherproofing nor heating: thin-shelled fiberglas domes, foamed polystyrene forms, even conventional trailer units. Rurik Ekstrom, architect, and the Research and Design Institute of Providence, R.I., estimate its total cost at $250,000.

The Davis, Brody system is modestly different, calling for no interior supports of any kind. Their Osaka experience—in association with Chermayeff and Geismar, and Rudolph deHarak, designers; and David Geiger, structural consultant—revealed new possibilities: "What opened up the most startling new vistas for planning and design," writes Bernard P. Spring of Davis, Brody and Associates, "was the discovery that this type of enclosure, vast and economical as it was, could as easily be made to cover a space a mile wide or five miles wide without significantly increasing its weight or the cost per square foot of area enclosed."

For Mr. Spring—who studied and taught architecture at M.I.T. and is now Dean of the School of Architecture at the City University of New York—this opens a whole new realm of possibilities for the academic community: "A structural system that captures and controls many square miles of the environment leads to a planning concept in which all the barriers and divisions that separate inside from outside and one activity from another could be eliminated. . . . The enormous freedom to move, change, reorganize, and rearrange spaces and activities that could be provided by a large-scale air-supported enclosure would make it possible to experiment freely with the interrelationships of educational activities—and their relationships to other activities throughout the community."



Women in Science, American Style

"Women's Liberation is perpetuating . . . unadulterated mythology about the history of women in science," Dr. Margaret Mead of the American Museum of Natural History declared to an audience of 160 women and eight men at the annual meeting of the American Association for the Advancement of Science this winter in Chicago.

The oppression of women by society is a false historical view, said Dr. Mead (although she conceded, "I suppose that the best revolutionaries have no facts"). "Women in the 1920's had a much easier time finding jobs than they do now, because there was a shortage of labor then."

"This dissatisfaction with suburban housewifery that we started hearing about at the end of the 1950's was not because women suddenly felt some spiritual disillusionment with suburbia. It was a response to a shortage of cheap, educated labor. The labor force needed to hire women, so pressures arose for women to do something besides housewifery," Dr. Mead said.

"Of course women have a hard time finding jobs today. So do men! There aren't any jobs!"

Other members of the A.A.A.S. "Women in Science" panel, and the audience which consisted mainly of middle-aged and older women, swapped views on being a woman and a scientist:

◇ A young mother, born "behind the iron curtain," who is now actively pursuing a scientific career, declared that many countries "cannot afford the luxury" of having most women, or half the labor force, stay at home to raise children. Since she moved to the United States, she said, she had found women who think it is their "right" to only raise children. In other countries, women feel a duty to join the work force.

◇ "Women's Liberation conceals a trap. There's so little to be envious of in the lives of the men I know. Women have more freedom of choice today than men. . . . We must not delude ourselves that all we want is a chance at male roles. Wider options are needed for both men and women in this society," said Ruth Hubbard, Lecturer in the Department of Biology at Harvard University.

◇ Both old and young women on the panels agreed that being a woman mattered most in one situation: job hunting in industry. Uniformly, they said, they had avoided working for industry because of lower pay, less status, and other forms of discrimination. Compared with these conditions, some went so far to remark that the life of a woman scientist in academia was relatively easy!

◇ Nevertheless, Arie Y. Lewin and Linda Duchin of New York University reported a survey finding that heads of university departments prefer an average-qualified man to an average-qualified woman. But "a woman with clearly superior qualifications, in competition with an average man, is likely to be recognized. However, these speakers represented one side. Not vocal at this particular session but active elsewhere during A.A.A.S. were a group of younger scientists of the Women's Liberation Movement. They insisted that the science professions, like many others, are male-dominated and discriminate against women. Indeed, at one point during the meetings a group of women robed in black—representing, they said, the Women's International Terrorist Conspiracy from Hell (or W.I.T.C.H.)—appeared at the opening of a panel to pronounce a "hex" on the entire proceedings.

Russian Women in Science

While American women scientists are questioning their roles as professionals, as wives, and as mothers *(see right)*, women in the Soviet Union have a relatively easy time pursuing these three roles at the same time.

Natalia S. Kislyak, Director of the Clinic of Childhood Diseases of the Second Moscow Medical Institute and First Deputy Minister of Health of the U.S.S.R., explained in a paper prepared for the A.A.A.S. meeting this winter (Mrs. Kislyak was unable to come to the U.S. and her paper was read in her absence by Dr. Mina Rees, a Vice-President of A.A.A.S.) that 58 per cent of all Soviet specialists are women. More than eight million Soviet women have higher and specialized degrees.

Mrs. Kislyak cited the efforts of V. I. Lenin, whom she said first opened the Soviet educational system, technical schools, and professional faculties to women. In 1927-28, women constituted 13 per cent of the members of technical institutions; by 1968-69 they made up 35 per cent. Lenin, she said, "realized that (women's education) was one of the conditions of the complete emancipation of the woman as a personality and of her active participation in the life of society."

Today the Soviet Union has a broad program of aid for women. They receive 112 days of paid maternity leave after each birth, and when a baby is one year old its parents may place it in a center which will provide care only during the working day, or where it will be cared for through an entire week, returning to the parents only for days off. Such institutions exist for all children's age groups and educational levels.

Puzzle Corner
Allan J. Gottlieb

An Ecological Setting

I am considering a small change in format. Currently we reserve one problem per month for bridge fans. But perhaps chess and computer enthusiasts should not be slighted. If there is interest, a rotating plan involving one or two of the problems per month could be arranged. Due to considerations of space and time, we are limited to five problems per issue to which solutions are printed, so any increase in reserved slots for chess, bridge, computing, etc., means a corresponding reduction in the number allotted to everything else. (The number of "speed"—i.e., unanswered—problems given is quite flexible.)

Readers who have suggestions or opinions on this matter, please write. Your inclinations will be very influential.

Problems

Our bridge problem is from Paul D. Berger:

26 Given the following hands, South the successful bidder at 4 spades, and the opponents' lead of ♣ 7:

	♠ K ♥ 9 5 4 2 ♦ K 7 ♣ K Q J 8 6 5	
♠ 8 6 ♥ K J 10 6 3 ♦ A J 9 6 3 ♣ 7		♠ 7 4 ♥ A Q 8 ♦ Q 4 3 ♣ A 10 4 3 2
	♠ A Q J 10 9 5 3 2 ♥ 7 ♦ 10 8 2 ♣ 9	

Do you choose offense or defense?

An old favorite in an ecological setting from John E. Prussing:

27 Three hoboes spent the day gathering aluminum cans to sell back to a can company for ½¢ each. That night they left the cans in a pile to be divided equally in the morning. During the night one hobo decided he wanted his share then. He divided the cans into three equal piles and had one odd can left over. He took his pile, pushed the other two piles back together, threw the odd can on the big pile, and stole away into the night with his cans. Later another of the hoboes did the same thing: three equal piles, one old can left over, took his share, threw the odd can on the big pile, ran away. Still later the third hobo did the same thing and had the same experience with one can. After the hoboes had left, the number of cans in the big pile was exactly divisible by three. In the morning a fourth hobo found the pile left behind by the others and sold them to the company. How much money did he receive? (Hint: it was less than 25¢.)

John (Boog) Rudy sends to us the following real-life problem:

28 While working on learning curve formulations I came up with
$A + 1 = N^{1-B} + AB$
I must solve this for B. I know that there is only one solution in the range $0 < B < 1$, for it is the answer to a real-life problem. How do I solve it exactly?

Stephen Kent submits the following problem which he encountered in a mathematics contest:

29 In how many different ways can eight numbers be rearranged such that no number occupies its original position? Check your answer by writing out all the possibilities. Next, find the answer for n numbers in general.

We conclude this month's offering with Charles Heiberg's analysis problem:

30 Given the notations
$f: R \to R$,
$\Delta_t f(x) = f(x + t) - f(x)$,
show that there exists f continuous such that
$\lim_{x \to +\infty} \Delta_t f(x) = 0$ for all rational t; and
$\lim_{x \to +\infty} \Delta_t f(x)$ does not exist for almost all (measure-theoretic) t.

Speed Department

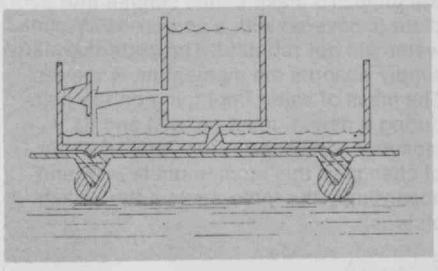
Frank Rubin sends us the following:

SD9 A flag pole erected in the center of a rectangular field is discovered to lean at an unknown angle. Bracing ropes from the corners of the field to the midpoint of the flagpole are found to have lengths of a, b, c, and x, going clockwise around the field. Find x as a function of a, b, and c.

Donald E. Savage says he "seems to get the message" that we need some "speed" problems, giving citations to four 1970 issues of *Technology Review.* Here is his, which he says "really is a 'speed' problem (intentional pun)":

SD10 It is often stated that for Newtonian physics one nonaccelerating frame of references is as good as another. Consider the case of a passenger in a train moving (and therefore not the Penn Central) with velocity V_t. Beside the track is a post on which a gun is mounted. The gun is aimed parallel to the track and in the opposite direction from that in which the train is moving. The gun's muzzle velocity is v. Thus, from the passenger's point of view, firing the gun raises the bullet's velocity from V_t to $V_t + v$. Thus the kinetic energy of the bullet is increased by
$\frac{1}{2}m(V_t + v)^2 - \frac{1}{2}m(V_t)^2$
$= \frac{1}{2}mv^2 + mV_tv$,
where m is the mass of the bullet. Since this energy came from the gunpowder, it appears that the energy available from the powder depends upon how fast the observer is moving.

Let's end by violating Newton's Laws—a problem in the September, 1970, issue of The *Physics Teacher* and there credited to Lewis Epstein:



SD11 We are all familiar with mechanisms supposed to violate the first law of thermodynamics, and some of us have even made acquaintances with mechanisms supposed to violate the second law of thermodynamics, but have you ever met one which presumes to violate Newton's first or second law? The mechanism about to be described is in-

tended to accelerate without the application of external force or the ejection and loss of reaction mass. The mechanism does require energy to operate.

A sled- or railroad-mounted prototype of the mechanism will be outlined; however, its immediate adaptation to space craft is apparent. The mechanism is truly the essence of simplicity. (Perhaps this is why it has not been previously noticed.) It consists of a water bucket with a hole punched in its side close to the bottom. The jet of water squirting from the hole impinges on a splash plate and then falls into a collecting basin. If desired, the cycle can be closed by a pump that lifts the water from the basin back into the bucket.

Since the prototype is railroad-mounted, only horizontal forces are of concern. Were the bucket not punctured, there would be no net horizontal force on it, since the horizontal pressure exerted by the water at any point on its side would be nullified by an equal but counter-directed pressure on the opposite side of the bucket. Punching a hole in the bucket upsets this balance. If a hole of effective area A is opened at a depth where the water pressure is P, the balance is upset by an amount PA, representing a net force F_b pushing on the inside of the bucket opposite the hole. So we have an elementary rocket.

Now we must consider the force, F_s, of the jet impinging on the splash plate. Offhand F_s would be expected to counteract the reaction force, $F_b = PA$, on the bucket. Let us see. In accordance with Torricelli, if energy is to be conserved, the velocity, v, of the water squirting from the hole must equal the velocity that a body would obtain when falling freely from the height, h, of the water surface to the hole. Whence:

$\frac{1}{2}v^2 = gh$.

Now, if the water has density, ρ, its pressure at the depth where the hole was punched must be:

$P = \rho gh$

and thus:

$P = \rho \frac{1}{2} v^2$

or:

$F_b = \rho \frac{1}{2} v^2 A$.

The counter force against the splash plate must be the time rate of change of the water jet's momentum as it strikes the plate. To make things simple, the plate is covered with a screen, so the water will not rebound. The plate then simply absorbs the momentum in the jet. The mass of water impinging on the plate during a time, t, must be ρvAt and its momentum must be $\rho v^2 At$. The time rate of change of this momentum is $\rho v^2 A$ and accordingly the force against the splash plate is:

$F_s = \rho v^2 A$.

So it turns out that:

$F_s = 2F_b$.

The force on the splash plate does not just counteract the reaction force on the bucket, it overwhelms it by a factor of two, and we must conclude there is a net force on the whole mechanism. The mechanism is compelled to accelerate in the direction of the splash plate.

What consequences this may foreshadow for interplanetary travel cannot be known.

Solutions

11 Given the hands shown and the bidding as listed,

	♠ 8 6 ♥ A K x ♦ Q 9 7 ♣ A 10 9 x x	
♠ A Q 10 x x ♥ Q J 10 x x ♦ x ♣ J x		♠ J 9 ♥ 9 x x x ♦ x x x ♣ K Q x
	♠ K x x ♥ x ♦ A K J 10 8 5 ♣ x x x	

South	*West*	*North*	*East*
1 diamond	1 spade	2 clubs	pass
2 diamonds	2 hearts	3 hearts	pass
3 no-trump	4 hearts	5 diamonds	pass
pass	pass		

and West's lead of the ♥ Q, show that if the declarer wins the first trick with the ♥ A then he must lose two spade tricks and a club when East gets in with the ♣ K.

The following is from John W. Meader: The only sure way to make 11 tricks is to ruff out the club suit. In order to do this without giving up a club to East, which would be fatal because of the spade return, South must find two club discards. He ducks the opening heart; wins the next lead—say a club (the best defense)—; draws one trump with the ♦ Q, throwing the ♦ J or ♦ 10 under it; discards two clubs on the top hearts; ruffs a club high; returns to dummy with a trump; ruffs another club high; wins a third diamond North; discards two spades on the last two clubs; and gives up a spade.

Also solved by Philip D. Bell, Winslow H. Hartford, E. C. Ingraham, R. Robinson Rowe, and the proposer, John Rudy.

12 Show that for every odd positive integer n, sin nx can be expressed in the form $\sin nx = a_1 \sin x + a_3 \sin^3 x + \ldots + a_n \sin^n x$ and derive a general formula for the coefficients a_k.

Gilbert Shen supplies the following calculation:

$$\sin nx = \text{Im}\,(\cos x + i \sin x)^n$$

$$= \text{Im} \sum_{k=0}^{n} (\cos^{n-k} x)(i \sin x)^k \binom{n}{k}.$$

The imaginary part of the R.H.S. consists of the sum of the odd k terms:

$$\sin nx = \sum_{k\ \text{odd}}^{n} \binom{n}{k} (\cos^{n-k} x)(\sin^k x) i^{k-1}.$$

Since both k and n are odd, n — k is even. Hence

$$\sin nx = \sum_{k\ \text{odd}}^{n} \binom{n}{k} (-1)^{(k-1)/2} \sin^k x (1 - \sin^2 x)^{(n-k)/2}$$

which is manifestly a polynomial in sin x. (Note that (k — 1)/2 and (n — k)/2 are integers.) The highest power in this polynomial is the term $(\sin^k x)(\sin^2 x)^{(n-k)/2}$ when k = n. This is just $\sin^n x$. Since sin nx is odd in x, we retain only the odd-powered terms in the expansion. Hence

$$\sin nx = \sum_{k\ \text{odd}}^{n} a_k \sin^k x.$$

To obtain an expression for a_k, define $y \equiv \sin x$. Then $\sin nx = \sin(n \sin^{-1} y) \equiv f(y)$ is a factor of y. Taylor expand about y = 0:

$$f(y) = \sum_{k=0}^{\infty} \frac{f^{(k)}(y)}{k!} \Bigg|_{y=0} y^k$$

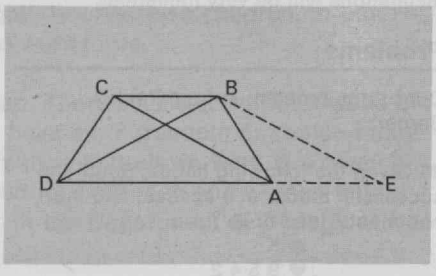
By comparison, it must be that

$$a_k = \frac{f^{(k)}(0)}{k!} = \frac{1}{k!} \left(\frac{d}{d \sin x} \right)^k \sin nx$$

at x = 0.

Also solved by Harold Donnelly, Winslow H. Hartford, Ivar and Carolyn Kist, R. Robinson Rowe, Donald E. Savage, Mark Schoenberg, and the proposer, Arthur W. Anderson.

13 Given a convex quadrilateral ABCD with diagonals AC and BD, and given that AC = BD
Angle BAC = angle CAD
Angle CBD = angle BDA,
prove that the quadrilateral is a trapezoid.



Robert Pogoff submitted the following geometrical proof, making the assumption that the problem is to prove that the quadrilateral is an *isosceles* trapezoid (or a square, which—as he says—obviously meets the requirements of the given conditions):

The problem is to prove CB ∥ DA and BA = CD.

1. Draw BE ∥ CA
2. Extend DA to E
3. DE∥ CB (angle CBD = angle BDA)
4. Angle BEA = angle CAD (BE ∥ CA)
5. Therefore CBEA is a parallelogram (two pairs of parallel sides)
6. Therefore BE = CA (opposite sides of a parallelogram)
7. CA = BD (given)
8. Therefore BE = BD
9. Therefore angle BEA = angle BDA (base angles of an isosceles triangle)
10. Therefore angle CAD = angle BDA
11. DA = DA
12. Therefore △CAD ≅ △BDA
13. Therefore BA = CD

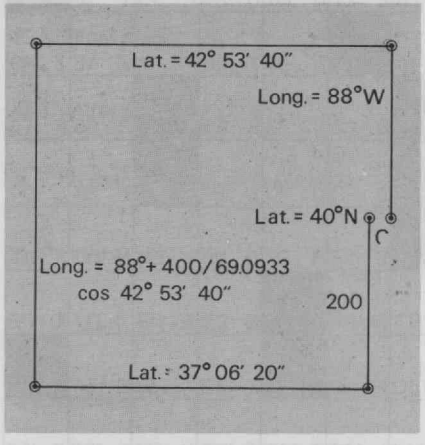
If angle BAD is a right angle, then it follows that all the acute angles are 45°,

all the triangles are isosceles, and CB = BA = AD = DC; then ABCD is a square. Note that the given fact, that angle BAC = angle CAD, is not necessary to prove that the quadrilateral is an isosceles parallelogram; nor is the term *convex;* it must be convex if angle CBD = angle BDA.

Also solved by Winslow H. Hartford, E. C. Ingraham, John L. Joseph, Mrs. Martin S. Lindenberg, Roger Milkman, R. Robinson Rowe, John Rudy, and Gilbert Shen.

14 Starting from a point 40° N. 88° W., a man walked 200 miles due north, then 400 miles due west, 400 miles south, 400 miles east, and finally 200 miles north. To his amazement, he was not at his starting point. How far away was he?

R. Robinson Rowe took care of this one rather easily:



Due to convergence of meridians, the man did not walk around a square but followed the path in the drawing. A precise solution on the Clarke spheroid would be very complicated, but it should be near enough to use a sphere with the geoid's average radius of 3958.794 miles. He will end at 40° N. latitude but west of his startnig point. Letting the latitudes of his second and fourth courses be N and S, the terminal gap G was
G = 400 cos 40° (sec N − sec S)
= 34.0449 miles.

Also solved by E. W. Beohne, Harold Donnelly, Harry V. Ellis, III, David H. Geisler, Winslow H. Hartford, Mrs. Martin S. Lindenberg, Gilbert Shen, Lawrence N. Smith, and J. Supine.

15 Given the following, find x and y in terms of a and c.
Jules Sandock submitted the following exhaustive solution:
Let A = a/c, Y = y/c, and X = x/c.
It is clear that v = y − a, u = x − a.
v/a = a/u
Let S = u/a, T = v/a. Then
ST = 1.
$1 = X^2 + Y^2 = (u + A)^2 + (v + A)^2$
$= u^2 + v^2 + 2A(u + v) + 2A^2$
$1/A^2 = S^2 + T^2 + 2(S + T) + 2$
$S^2 + T^2 = (S + T)^2 - 2ST$
$= (S + T)^2 - 2$
$1/A^2 = (S + T)^2 + 2(S + T).$
Let R = S + T; then
$1/A^2 = R^2 + 2R$
$1/A^2 + 1 = (R + 1)^2$
$R + 1 = \sqrt{1 + 1/A^2}$
$R = \sqrt{1 + 1/A^2} - 1$
It is given that S + T = R
and that ST = 1.
$S = R - T = R - 1/S$
$S^2 = RS - 1$
$S^2 - RS = -1 = (S - r/2)^2 - R^2/4$
$(S - R/2)^2 = R^2/4 - 1 = (R^2 - 4)/4.$
From the figure, x > y, u > v, and
S > T; so S > R/2 and T < R/2.
R = S + 1/S > z (unless S = 1,
T = 1, and v = u)
$R^2 - 4 > 0$
$S - R/2 = \sqrt{R^2 - 4}/2$
$S = \frac{1}{2}\{R + \sqrt{R^2 - 4}\}$
$T - R/2 = -\sqrt{R^2 - 4}/2$
$T = \frac{1}{2}\{R - \sqrt{R^2 - 4}\}$
$X = u + A = A(S + 1)$
$= A/2\{R + 2 + \sqrt{R^2 - 4}\}$
$= A/2\sqrt{R + 2}\{\sqrt{R + 2} - \sqrt{R - 2}\}$
$Y = v + A = A(T + 1)$
$= A/2\{R + 2 - \sqrt{R^2 - 4}\}$
$= A/2\sqrt{R + 2}\{\sqrt{R + 2} - \sqrt{R - 2}\}$
$R + 2 = \sqrt{1 + 1/A^2} + 1$
$R - 2 = \sqrt{1 + 1/A^2} - 3$

$$X = A/2\sqrt{\sqrt{1 + 1/A^2} + 1}\left\{\sqrt{\sqrt{1 + 1/A^2} + 1} + \sqrt{\sqrt{1 + 1/A^2} - 3}\right\}$$

$$Y = A/2\sqrt{\sqrt{1 + 1/A^2} + 1}\left\{\sqrt{\sqrt{1 + 1/A^2} + 1} - \sqrt{\sqrt{1 + 1/A^2} - 3}\right\}$$

x = cX and a = cA, so

$$x = a/2\sqrt{\sqrt{1 + c^2/a^2} + 1}\left\{\sqrt{\sqrt{1 + c^2/a^2} + 1} + \sqrt{\sqrt{1 + c^2/a^2} - 3}\right\}$$

$$y = a/2\sqrt{\sqrt{1 + c^2/a^2} + 1}\left\{\sqrt{\sqrt{1 + c^2/a^2} + 1} - \sqrt{\sqrt{1 + c^2/a^2} - 3}\right\}$$

$c/a = 2\sqrt{2}$

$$x = a/2\sqrt{\sqrt{1 + 8} + 1}\left\{\sqrt{\sqrt{1 + 8} + 1} + \sqrt{\sqrt{1 + 8} - 3}\right\}$$

$= a/2\sqrt{4}\{\sqrt{4} + u\} = a/2\,(2)(2) = 2a.$

Also solved by William Burgess, Harold Donnelly, Arup Dravid, Edward S. Gershuny, William Glassman, Winslow H. Hartford, John W. Meader, R. Robinson Rowe, John Rudy, Jules Sandock, Donald E. Savage, Gilbert Shen, J. J. Sytek, and the proposer, John L. Sampson.

Better Late Than Never

Two communications concerning problems in Volume 72 have been received; A. Porter has submitted a solution for problem **40,** and George O. Smith makes the following significant contribution on problem **43,** to which "so-called" (his word) solutions were accepted in the January issue:
I cry foul! You have violated one of the most sacred tenets in geometry by permitting the appearance of irrationals in the argument. Irrationals are proscribed —and aside from a few notable coincidences, the transcendental functions are irrational. Thus your "solutions" are no more than approximations. Besides, the argument is more elegant if we observe:
1. The five points of the star lie on a circle and are equidistant.
2. Therefore, all acute angles are equal; all obtuse angles are equal; and all triangles are isosceles.
3. Angle AEB = angle BEF = angle EFA (either base is twice the vertex angle).
4. Thus the acute triangle DAF is that special case in which
DF/AD = AD/(DF + AD),
which is the so-called "golden mean," and thus the "width" AD is incommensurate with the "separation" DF.
5. Thus the problem cannot truly be solved, since the "golden mean" is itself irrational. The "golden mean," by the way, is 1.61803, the only "number" that becomes its own reciprocal simply by subtracting 1.000. The five-pointed star, also called either the "pentangle" or the "pentagram," is also the emblem of the Pythagorean Brotherhood, a mystico-religious organization that believed that all numbers were whole and which came unglued when one of the members proved, by argument, that the diagonal of a square is itself incommensurable with the side since it, too, is irrational. Such lines can be drawn, but they cannot be defined nor described in finite terms.

E. W. Boehne and William Burgess also responded to problem **43.**

Solutions have come to problems in Volume 73 as follows:
6 Herbert Messenger, Albert Morris, and Patrick J. Sullivan.
7 Lance Wilson.
8 William Burgess.

Allan J. Gottlieb, who graduated from M.I.T. in 1967, teaches mathematics at Brandeis University. Send problems and solutions to him at the Department of Mathematics, Brandeis University, Waltham, Mass. 02154.

Tech-Crostic
David L. and Judith G. Holt

Of Glaciers and Biblical Plants

■	■	■	■	■	■	■	■	N 1	G 2	M 3	E 4	L 5	■	Y 6	U 7	K 8	■	W 9	B 10	D 11	M 12	L 13
C 14	J 15	N 16	O 17	■	M 18	R 19	H 20	■	D 21	Z 22	A 23	L 24	S 25	V 26	E 27	H 28	U 29	K 30	I 31	■
X 32	W 33	■	X 34	C 35	N 36	F 37	K 38	G 39	E 40	M 41	■	F 42	T 43	I 44	■	B 45	F 46	W 47	K 48	Z 49
S 50	V 51	J 52	X 53	■	N 54	I 55	G 56	M 57	K 58	■	I 59	L 60	V 61	■	Q 62	Y 63	F 64	■	P 65	F 66
S 67	B 68	M 69	E 70	K 71	■	D 72	W 73	K 74	X 75	E 76	A 77	T 78	U 79	■	Q 80	U 81	N 82	■	L 83	C 84
F 85	E 86	N 87	A 88	S 89	■	Z 90	F 91	■	I 92	P 93	■	A 94	R 95	■	O 96	H 97	D 98	K 99	N 100	F 101
■	V 102	X 103	■	Y 104	F 105	X 106	■	F 107	W 108	C 109	K 110	Y 111	B 112	U 113	M 114	■	E 115	C 116	K 117	T 118
E 119	■	A 120	L 121	H 122	F 123	M 124	■	R 125	Z 126	■	Q 127	C 128	R 129	V 130	M 131	■	Z 132	I 133	K 134	■
R 135	Z 136	■	S 137	N 138	T 139	D 140	F 141	W 142	P 143	E 144	G 145	■	K 146	F 147	L 148	O 149	C 150	Y 151	L 152	E 153
W 154	A 155	P 156	■	Y 157	I 158	■	J 159	M 160	C 161	S 162	F 163	G 164	■	X 165	Z 166	J 167	O 168	K 169	I 170	P 171
■	S 172	F 173	I 174	A 175	■	O 176	Q 177	D 178	F 179	■	D 180	T 181	C 182	Y 183	I 184	X 185	F 186	■	Z 187	X 188
■	I 189	K 190	G 191	M 192	D 193	J 194	U 195	F 196	■	T 197	Y 198	■	E 199	Q 200	P 201	L 202	B 203	M 204	R 205	H 206

Use the definitions at the right to help define the words to which they refer; then enter the appropriate letters in the diagram to complete a quotation from a scientific work. The first letters of the defined words give the author and title from which the quotation is taken. Black squares in the diagram indicate the ends of words; when there is no black square at the right end of the diagram, the word continues on the next line.

The correct solution to this Tech-Crostic will appear in the May issue of *Technology Review*.

David L. Holt is Assistant Professor of Metallurgy at M.I.T. He will welcome readers' comments; address him in care of *Technology Review*, Room E19-430, M.I.T., Cambridge, Mass. 02139.

A. Congenitally united.

23 94 77 155 88 120 175

B. Remains.

68 203 112 10 45

C. Instrument for measuring minute quantities of radiant heat.

182 35 161 128 109 84 14 150 116

D. Auxiliary initial flight propulsion (2 words).

11 98 178 193 140 21 72 180

E. Pertaining to toothache.

40 115 76 144 86 27 70 4 153

199

F. Part of the curse on Adam (6 words, followed by Word K).

101 46 37 173 105 123 196 85 186

64 42 91 163 66 179 107 147

119 141

G. Decisive moment.

191 2 39 164 56 145

H. Ridge of glacial deposit.

20	206	122	97	28

I. Liquid used as a hypnotic.

92	59	158	133	170	44	184	55	31
	174	189						

J. Cavity; depression.

159	15	52	167	194

K. Three words—see Word F.

134	74	48	146	58	110	30	169	99
	71	38	117	8	190			

L. Stupidity; unrefined quality.

13	60	121	202	148	83	24	5	152

M. Substance which distorts perception.

131	18	192	204	3	57	69	124	160
	114	12	41					

N. Characteristic of the Eastern Hemisphere (2 words).

16	100	82	54	138	87	36	1

O. Leaflet.

149	176	17	96	168

P. Biblical plant.

93	171	65	156	143	201

Q. Central part of Vietnam.

80	177	62	200	127

R. Odd game played to break a tie.

95	129	125	135	205	19

S. Propelled weapon.

172	50	137	25	162	89	67

T. Not well; in trouble.

181	78	139	197	43	118

U. Hemlock.

79	7	81	29	113	195

V. One of a people of central Caucasus.

51	26	102	61	130

W. Bond; intercommunication.

47	9	108	142	73	154	33

X. Nun who attends to the affairs of the convent in the world (2 words).

103	165	75	53	32	34	185	106	188

Y. Flag; spec. ensign in medieval Italy.

111	63	198	6	104	183	157	151

Z. Valley in western U.S.

126	187	166	136	132	90	49	22

March Tech-Crostic Solution

The individual pressure recordings in various parts of the pulmonary venous system are meaningless unless they are considered with the simultaneous recordings of pressures in the pulmonary artery and the left atrium.
—D.M. Aviado, *The Lung Circulation.*

Bio-cans, Soft Options, and Turbocars

Recycling Returnables

To the Editor:
To Victor Cohn's discussion in the December issue (*pp. 8-9*), add another item to the things which "we-have-not": it appears that we have not an attitude held by other people which helps them to follow more trails for solutions to their problems than we do.

This is to provide an opening for one of my favorite developments: *Science Journal* magazine reported last year an item not mentioned yet in American efforts to deal with beverage containers, the item being British production of a plastic film-lined cardboard can which is fully biodegradable on exposure to weather and capable of containing beer, fruit juices and most other popular drinks for quite acceptable periods on store shelves.

American activity seems confined to returnable containers or movements to establish "recycling centers." Who's in charge here?

Jay Hart
Austin, Texas

"Blatantly Political"

To the Editor:
I wish to register a protest in regard to Victor Cohn's article in the December, 1970, issue. It is blatantly political and is simply bitter and overbearing in tone. It was completely out of keeping with the generally objective viewpoint presented in the *Review*. Someone should be given "equal time."

William E. N. Doty
Houston, Texas

Cholesterol Clarified

To the Editor:
In the next to the last paragraph of the Trend of Affairs piece "Butter is Blameless—Maybe" (see *Technology Review* for December, 1970, p. 61), speculation is made on differences in the amount of blood cholesterol that might occur among populations. I think it is a mistake to speculate about differences that might occur in a specific comparison, i.e. with a Japanese group, particularly when a possible result was indicated. This can mislead someone reading one article quickly and has no basis in fact. It would have been better to say simply that differences might occur among different groups and let it go at that.

William Lewis
Linwood, N.J.

Entrepreneurs—Ten Years Later

To the Editor:
Professor Edward B. Roberts' article ("How To Succeed in a New Technology Enterprise," *December, pages 22-27)* is one of the few systematic studies which I have seen of the technological entrepreneur. Most of the companies he studied were started in the 1950's and early 1960's, and most benefited from research and development contracts performed under the prevailing cost-plus system, under which most of the working capital (in the form of progress payments) and nearly all of the risk of overrun was assumed by the customer and not by the entrepreneur. This government-contract environment also permitted the growth of many new ventures which were far advanced technologically but did not have ready markets for their output in the civilian marketplace. These companies had little need of venture capital.

In contrast, in today's markets equity capital for new ventures is scarce and is available only to very few companies on what often must seem difficult terms. In a tight money environment, venture capital demands a very high projected rate of return in a relatively short time. One rule-of-thumb which had wide currency in 1968 was that a venture capitalist should expect ten times his money, if all went well, in three years. By contrast, during the dark days of mid-1970, venture capital "deals" that were placed at all tended to be done at around twice projected after-tax earnings for 1972 (not 1973)—a far harder bargain, and one which often precluded financing for the technically exotic ventures whose earnings were likely to be further out in time.

Undoubtedly, a number of very promising high-technology companies were founded in 1968, survived 1970 without reporting profits, and will be the Xeroxes of the future, but it is doubtful that many of them had to raise money recently in order to survive. One category of company seemed to flourish in 1969-70 without much capital, just as Professor Roberts' companies had ten years earlier: the consulting service and "software" firms specializing in urban problems, education, manpower training, and the like—again under government contract. Indeed, the conditions under which new ventures in these areas flourish today so closely parallel those which prevailed for the electronic hardware firms a decade ago that I hope Professor Roberts will study these as his next project.

Raphael Soifer
Washington, D. C.

In Defense of Secretaries

To the Editor:
In "A New Look at Clinical Schedules" (Technology Review *for December,* 1970) John F. Rockart writes (p. 37) of the "failure of appointment secretaries to extract enough information from incoming patients" and of "scheduling errors caused by insufficient information."

The poor secretary blamed again! Do you or Dr. Rockart confess all, verbally or on paper, to strangers—even if you could remember all details of past body functions with details of treatments? Patients are notoriously secretive and forgetful.

Remedy: a few key trap questions can be made up that will finger the unreliable patients for a clinic doctor to steer in the right direction.

Marshall Eskridge, M.D.
Mobile, Ala.

On Perpetuating Ignorance About Nonpolluting Cars

To the Editor:
In his report of the 1970 Clean Air Car Race (Technology Review *for January, pp. 20-29*), Bruce S. Schwartz laments the lack of good steam cars, and seems to imply some sort of conspiracy. I would

like to see an exposé of such vile plotting, but I suspect that the difficulty is that Mr. Schwartz is quite unaware of the real problems of Rankine cycle automotive power plants. Otherwise he would not have described them as having an obvious and unbeatable simplicity.

I also found more naiveté than understanding in Mr. Schwartz' comments on the gas turbine car. A "standing joke"? Only to those who know little or nothing about automotive gas turbines. The gas turbine engine used in the M.I.T. car came from military service, where its actual use was to provide electric power for a Navy flying boat when *not* flying. I have dissected a number of these obsolescent surplus engines and found all to have been damaged in varying degrees by using leaded gasoline (since the airplane had reciprocating propulsion engines, the crew never would keep kerosene for the A.P.U.). Was the C.A.C.R. engine checked for such damage? In perfect condition, its low thermal efficiency and 1955-vintage combustor would have foredoomed its chances of winning on an emissions basis, even if it had been run on propane or alcohol. Why was the installation so noisy? That particular engine and a variety of similar machines have had good muffling systems in operation for five to ten years. Did anybody bother to check this out?

Or did anybody bother to compare that engine with current and past (Chrysler) automotive gas turbines? The differences are significant—no regenerator and no free turbine. Single-shaft engines like the GTP70 are generally regarded as unsuited for automotive service because of difficult transmission requirements. Some of the proposed solutions of single-shaft turbine engine advocates (and their numbers are growing) are various electric drives. All of these pose formidable control problems. I think the M.I.T. team is to be congratulated in getting a single-shaft turbine with an electric power system to cross the continent. In so doing they vastly impressed some hot-rod journalists by breaking traction at highway speeds. Knowing what a GTP70 can do, I suspect the "massive power" so demonstrated came from a sudden electrical overload accompanied by a rapid deceleration of the gas turbine—those rotors have a lot of stored flywheel energy at 40,000 r.p.m.

Even though the gas turbine electric drive was too heavy and expensive, I would expect the results of this experience to be a valuable contribution to automotive gas turbine technology. At the very least, this is the first highway-operated turbocar with a single-shaft gas turbine. Perhaps it was a "standing joke," but to perpetuate the giggling of ignorance does not speak well of a journalist who can be expected to have some expertise.

Homer J. Wood
Sherman Oaks, Calif.

Work Hard, Ask Questions, Remember

To the Editor:
In "The Ecological Trap" (January, pages 30-37), Dr. Benson R. Snyder notes that young people are asked to show creativity yet may be marked on recall by rote, and that many are discouraged by being asked to give too much attention to detail. Yet it happens that creativity does involve storing a wide range of data in the memory, working hard on a problem to generate the necessary mental programs, then hoping that the subconscious will carry on after we ostensibly leave off. It works on everything from the making of inventions and the study of the laws of nature down to crossword puzzles. Initially, hard work and wide reading are required. At the same time, we must distinguish between learning techniques and the setting up of basic laws. And any educational system must encourage people to question what everyone else accepts.

An example is our attitude towards the Special Theory of Relativity. Too frequently its successes have led to a technological attitude of mind: "It works; why worry about any weakness of its postulates?" Basic science demands much more; a change in viewpoint usually leads to new progress.

Edward Adams Richardson
Bethlehem, Penn.

A Balanced View of Vegetation Control

To the Editor:
In considering the by-products of any military action (see "After the War Is Over" in Trend of Affairs, *Technology Review* for January, pp. 71-72 and Victor McElheny's column for March, pp. 12-13), one must not ignore details about combat and one must specifically recognize that high-speed metal fragments cause the vast preponderance of casualties.

The attempt to establish defensive positions in a jungle, or to reconnoiter long and thickly jungled borders, or to prevent ambush along roadsides requires some kind of vegetation control. I think that you will find that herbicides are far less destructive of human life, civilian and military, than the consequences of ambush, bombardment, and infiltration of well-armed men. Examine the casualty lists in Vietnam.

As far as food shortages are concerned you will probably learn that only upland rice has been destroyed and that rice is available from the Mekong Delta rice bowl (never sprayed), to the extent that it can get to market. The war has damaged the Vietnamese agricultural economy, but some crops are produced in greater quantities than before. After the war, which is what your article questioned, we will see far greater productivity per acre in Vietnam as a result of improved agricultural practices.

The Montagnard refugees, as with every other segment of Vietnamese society, have had their lives altered involuntarily. Societal disruption and destruction is not unique to the war in Vietnam. If the Montagnards lived in Tay Ninh province, along the border between Cambodia and South Vietnam, they would have been subjected to massive intervention from the outside whether by defoliants, troops, or high explosives.

I hope that you press further into the consequences and controversies of Vietnam and invite comments from military and civilian authorities, American and Vietnamese. Our view of events in Vietnam, Cambodia, Laos, and Thailand has influenced every aspect of American life. I believe that the influence has been terribly damaging, perhaps fatal, because of lack of debate. There have been many speeches and one-sided interviews, but rarely face-to-face debate. The herbicide story is but one example.

Roy M. Sachs
Davis, California

The author is Professor of Environmental Horticulture in the College of Agricultural and Environmental Sciences, University of California (Davis).—Ed.

"A Feeble Gesture?"

To the Editor:
"Blacks, Polaroid, and Apartheid" (*see* Technology Review *for January, pp. 79-80*) touched the main issue—upward job mobility—in the next to the last sentence. Perhaps a better title would have been, "Polaroid—Reformed Sinner" or "Polaroid: Doing Business at the Same Old Stand."

In spite of your kudos for "a long nationally distinguished record of hiring and training and promoting American Blacks," for me the record is not long enough. Approaching a Ph.D. in chemistry at M.I.T. in 1942—six months after Pearl Harbor—I sought in vain an interview with Mr. Land. I was shuffled from underling to underling on five different occasions and never met "The Man." Since 53 other corporations larger than his refused to hire me because I was Black, I must assume that he was conforming.

If he felt I was not competent, then the record does not bear him out. In some companies it takes 20 to 30 years to develop a top-level executive. I still wonder how much of the company's fervor came from Executive Order 8802 (F.D.R.'s Fair Employment Practices Order) and subsequent legislation; how much comes from a genuine desire at the top for a strong, racially integrated company. The gift itself is a feeble gesture guilt-ridden in conception, tragi-comic in execution.

Henry A. Hill
Haverhill, Mass.

The author is President of Riverside Research Laboratory, Inc.—Ed.

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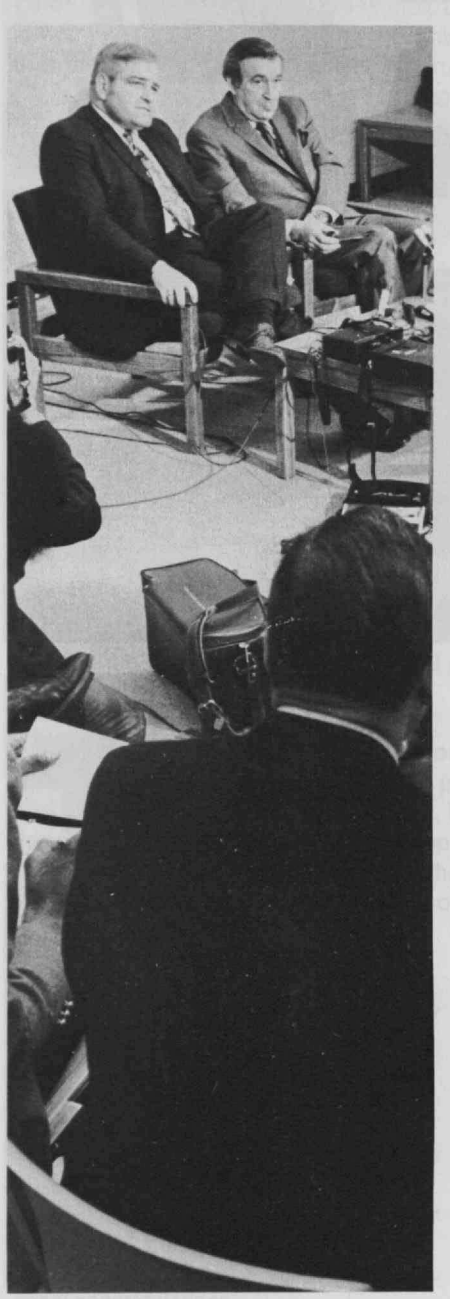
TR-71

Special Report

Jerome B. Wiesner and Paul E. Gray: The 13th President and His Chancellor



If the presidency of a modern university is a superhuman task, can it instead be conquered by a two-man team? When on March 5 the M.I.T. Corporation's Committee on the Presidency nominated Jerome B. Wiesner, Provost, and Paul E. Gray, '54, Dean of Engineering, to be President and Chancellor, respectively, the Committee was proposing an affirmative answer. The Corporation approved unanimously.

So did most of the faculty, the students, and President Howard W. Johnson, who becomes Chairman of the Corporation on July 1 following the retirement of James R. Killian, Jr., '26. "These are the right men for this time," he told the faculty, "and I think they are going to do a great job."

As Chancellor, Dean Gray will be President Wiesner's deputy in all matters, and he will be a member of the M.I.T. Corporation. "The appointment of a Chancellor," said James R. Killian, Jr., '26, Chairman of the Corporation, "recognizes the heavy and unusual responsibilities which must be carried by senior officers (of M.I.T.) and the consequent need for a greater sharing and delegation of administrative responsibilities. . . ."

Strenuous Discussion

Though widely predicted, Dr. Wiesner's selection as President was by no means a rubber-stamp shoe-in. James B. Fisk, '31, who chaired the selection committee, told the faculty at a special meeting on March 5 that the Committee had met 21 times in the six months since it was appointed in September and had received between 300 and 400 letters. Each member of the committee—seven members of the Corporation, of whom six are alumni of the Institute—in addition met individually with many students, faculty, and administration, with numerous alumni, with many friends of the Institute, and with a number of potential candidates.

He sought to leave the impression, Mr. Fisk told the faculty, "that we have been extremely thorough."

Paul V. Keyser, Jr., '29, President of the Alumni Association who served as a member of Mr. Fisk's committee, reported later on the same day to the Alumni Association Board of Directors that the committee had conducted an intensive review of the Institute's needs and of all available candidates.

The selection of Dr. Wiesner and Dean Gray has many meanings for the Institute. Here are some of them:

A Senior Statesman

◇ Perhaps for the first time in the Institute's history, the Presidency of M.I.T.

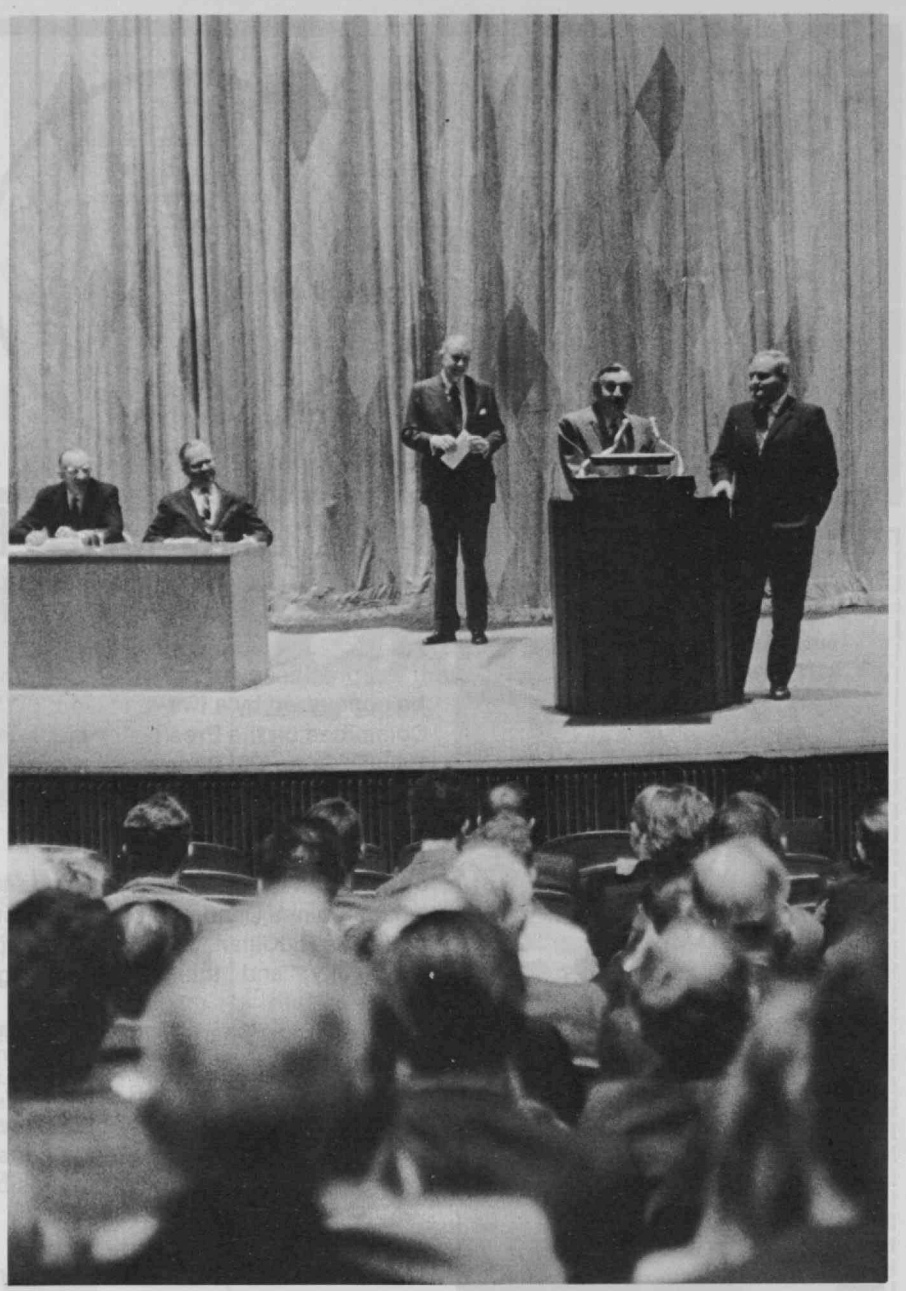
Jerome B. Wiesner: Toward Technology and Moderation

Jerome B. Wiesner is a remarkable engineer (though frequently considered a scientist) who has achieved very great triumphs in public life while retaining a reticence of manner that effectively disguises from casual acquaintances the power of his intellect and force of his conscience.

Dr. Wiesner first came to M.I.T. in 1942 to join the Radiation Laboratory and soon became Associate Leader of the Radiofrequency Development Group. Earlier, after a childhood in Dearborn, Mich., where his father was a drygoods merchant, Dr. Wiesner had attended the University of Michigan (B.S. 1937, M.S. 1938, and Ph.D. 1950, all in electrical engineering), served with the University's radio broadcasting service, and was Chief Engineer for the Acoustical and Record Laboratory of the Library of Congress in Washington.

In 1945, as World War II came to an end, Dr. Wiesner joined the staff of the Los Alamos National Laboratory, but he returned to M.I.T. in 1946 as Assistant Professor of Electrical Engineering; one year later he was Associate Professor and in 1950 became Professor, in 1962 Institute Professor. Meanwhile, he served in the administration of the Research Laboratory of Electronics, then directed by Julius A. Stratton, '23, who later became President of the Institute; Dr. Wiesner was himself Director of R.L.E. for nine years beginning in 1962, and for three of those years he was also Acting Head of the Department of Electrical Engineering. During this period—until 1961, when Dr. Wiesner was called to Washington as Science Adviser by the late John F. Kennedy—Dr. Wiesner's leadership in the fields of microwave theory, communications science, scatter transmission techniques, and the application of statistical methods to communications engineering helped make M.I.T. one of the leading electronics research centers in the world. Since 1964 Dr. Wiesner has been a member of M.I.T.'s top administration, first as Dean of the School of Science and later—since 1966—as Provost working closely with Howard W. Johnson, President of M.I.T.

Dr. Wiesner has been a frequent consultant and adviser to government agencies—notably the Departments of Defense and of Health, Education and Welfare. He was named by President Eisenhower to the President's Science Advisory Committee in 1957, and he was earlier associated with studies of national defense planning for the Air Force and the Department of Defense. His selection by the late John F. Kennedy as Presidential Science Advisor led to a close personal friendship—and to a continuing series of public and private assignments concentrating on the interplay between science and public policy. And in the course of these he has become identified as an opponent of the war in Indochina and of the arms race, an insistent ad-



comes into the hands of a man who is a senior statesman of American science even before he assumes the Institute's leadership. For nearly a decade he has participated in discussions and policy making affecting, the role of science in U.S. defense and the economy, and in international understanding.

◊ Two electrical engineers—one known for communications research and one for outstanding teaching—will be M.I.T.'s chief officers. Dr. Wiesner, speaking to members of the Alumni Association's Board of Directors less than six hours after the announcement of his selection to President, said that one of the "great things about M.I.T. is that engineering is a prime and respected central part of our community." Mr. Keyser told the Alumni Association Directors that the team of Dr. Wiesner and Dean Gray is "remarkably endowed to continue the best traditions of M.I.T. as a great engineering and scientific school."

◊ Continuity of M.I.T.'s management and direction seem assured. Receiving the ovation of the faculty at the special meeting on March 5, Dr. Wiesner said, "I was really not my first choice for this post; Howard Johnson was. . . . If I have any single goal," Dr. Wiesner told the faculty, "it is working with you to continue the kind of leadership we have had in the past."

Later, Dr. Wiesner told the press that, because "I've had a strong hand in shaping many of the decisions that involve what we're doing now, I don't see that there is a call for any major change in direction." Dean Gray agreed: "It is the entire place that makes things happen," he said. "I look forward to participating in an exciting time." Speaking for both of them, Dr. Wiesner told the press that the principal challenge to M.I.T. "is to continue to deserve the reputation that this institution has for leadership in education, research, and public service."

In discussing the appointment, Mr. Keyser told the alumni that President Johnson called Dr. Wiesner "a tower of strength" in dealing with the many critical problems of the last five years.

The Problems of a Troubled World

◊ If there is any new emphasis in M.I.T. activities, it will be on the usefulness of science and engineering for urgent problems, on the humane uses of new technology. Mr. Fisk reported to the faculty that an understanding of the role of science and technology in relation to the goals of society was high on the list of qualifications sought by the Presidential Selection Committee. Dr. Wiesner himself spoke to the faculty of his conviction that "the problems of a troubled world are the ones to which we can make a major contribution." Later, Dr. Wiesner told the press that "the way to use science and technology in the most beneficial manner . . . is going to be a key problem as we move ahead."

Expanding on his views for members of the Alumni Association Board of Directors, Dr. Wiesner contrasted the past and future conditions for scientific and engineering progress. In the past, he said, the greatness of M.I.T. could depend on the greatness of a few people whose individual contributions were outstanding. But now "the problems that lie ahead in trying to make science and engineering serve us are much more difficult. They require a greater

"There is only one goal for all of us," Jerome B. Wiesner told the M.I.T. faculty after being designated the Institute's 13th President: "To continue to deserve the reputation of this institution for teaching, research, and public service." With him at the historic faculty meeting on March 5 was Paul E. Gray, '54, Chancellor-elect; James R. Killian, Jr., '26, Chairman of the Corporation (standing behind) had just introduced them, and E. Neal Hartley, Secretary of the Faculty, and President Howard W. Johnson were also on stage. Later both candidates received warm personal congratulations.

vocate of disarmament and international arms control.

But Dr. Wiesner's thinking on social and scientific affairs goes far beyond these highly political issues. An interesting summary appears in his essay, "Reflections on Identity," written for the 1970 edition of the M.I.T. yearbook, *Technique:* Dr. Wiesner describes the "three-body problem" facing society: "A crisis of vast proportions exists in [our] civilization relating to the questions of whether or not the social and control mechanisms of society can evolve fast enough to manage adequately the ever-emerging new technologies and the mass irrationalities they seem to breed.

"While the uses of technology and social innovations have greatly increased the security of the individual, they have at the same time posed great new dangers for the collective society over which no one seems to have any control and against which there is no defense. . . . We have here the most serious dilemma of our times—students so distraught by their inability to identify a meaningful life for themselves that in their anger they may destroy the one institution through which they could possibly create a world to their liking.

"Leadership and understanding for evaluation of a new, more decent society can come only from a university free to question, explore and experiment. . . . [In this environment], what M.I.T. becomes depends upon two things: how fully we are able to realize the opportunities inherent in our educational experiments and how successful we are in developing major activities that effectively relate the Institute's technological capabilities, its social science efforts, and a humanistic moderation."

Paul E. Gray: Toward Sustained Self-Education

If Dr. Wiesner's background as an engineer (*above*) is hidden behind a facade far more typical of a scientist, Paul E. Gray, '54—who becomes Dr. Wiesner's deputy as Chancellor of M.I.T. on July 1—is engineer and educator from the ground up. He has been at M.I.T. (except for two years of service in the U.S. Army from 1955 to 1957) ever since coming to the Institute as a freshman from Livingston, N.J., in 1950; and he has been a member of the Department of Electrical Engineering—first as student, then as teacher—since he selected that field as his undergraduate major in 1951.

Professor Gray's talents as an engineer were obvious even during his undergraduate career, and he was identified as an effective instructor almost as soon as he began teaching. His uniquely crisp and incisive use of the language are a reflection of his ability to sort out problems and reach solutions—qualifications equally important in engineering and ed-

ucation. In 1958 he won a departmental award for excellence in teaching, and for the past three years he has held the Class of 1922 Professorship, a chair established by alumni "for the purpose of rewarding and encouraging superlative teaching."

Professor Gray's interest in engineering education quickly spread far beyond his own field of semiconductor electronics and circuit theory. He became Chairman of the Freshman Advisory Council in 1964 and a year later Associate Dean of Student Affairs with primary responsibility for first-year students. His interest in freshmen and orientation continues; but he sometimes fears that "there is really no way that one can come to understand the M.I.T. experience except by living here."

Dean Gray's direct association with Dr. Wiesner began with his appointment as Assistant Provost in 1967, where he held primary responsibility for the development of undergraduate education and where he also was in charge of the programs extending M.I.T.'s educational opportunities to minority-group students —activities to which he has made major and innovative contributions and which might, without his constant nourishment and guardianship, have been substantially less effective.

Only four months ago President Howard W. Johnson named Professor Gray to be Dean of M.I.T.'s School of Engineering—hence Dean Gray's comment upon being introduced to the faculty at its special meeting on March 5: "Well, a funny thing happened on the way to the Dean's office. . . ."

In an address during the Institute's Independent Activities Period this winter Dean Gray outlined his view of an appropriate undergraduate curriculum in engineering. It must have three aspects, he said, providing such basic skills as mathematical ability and facility with models, an appreciation for real-world engineering applications, and individual independence.

Of the three, the last—which Dean Gray defined as "the capacity for sustained self-education"—is the most important.

But three hazards must be avoided if these objectives are to be successfully realized, warned Dean Gray: 1. the "ecological trap" of a too-total adaptation to learning basic skills, which may block a student's progress to creative independence; 2. faulty predictions of the future directions of technology, which may cause a student's education to be outdated before he is able to use it; and 3. the temptations of efficiency, which may lead a student to sacrifice initiative and creativity in order to maintain a fast schedule or high grades through his undergraduate career or may influence the institution toward uniformity in its educational programs.

understanding of the whole spectrum of science, engineering, and the social sciences. Future contributions," he said, "will depend much more upon all those in the institution working together."

◇ The choice of Dr. Wiesner and Dean Gray is popular in Cambridge; Dr. Wiesner is known to have been the first choice of both the faculty committee formed to consult with the Corporation (*see* Technology Review *for December, p. 81*) and the Corporation's Joint Advisory Committee on Institute-Wide Affairs, the principal channel for community opinion.

The Importance of Alumni

◇ Alumni relations may be more difficult—at least for the immediate future. Mr. Keyser admitted to the Association's Board of Directors on March 5 that he knew alumni who had "many reservations" about Dr. Wiesner. But he assured the Board that the Presidential Selection Committee's final choice had been unanimous and made with great enthusiasm for the future, and in presenting him to the Board he told Dr. Wiesner that "no one knows the opportunities and problems of this institution better than you do. If we are to remain at the cutting edge of technological progress, it is terribly important for alumni to understand and interact with us more intimately than ever before."

For himself, Dr. Wiesner admitted to the Board that "alumni have a different hold and sense of this institution than I. But after 30 years I have come to live it in the same warm way that you do," he said. "I believe it is the greatest scientific and technological institution in the world, and I have felt that I could not have been luckier than in coming here."

◇ The recent trend to increasing the flexibility—but without decreasing the rigor—of M.I.T. undergraduate education will continue. Dean Gray, in the past responsible for many aspects of the undergraduate academic program, told the press conference on March 5 that "our focus in the years ahead to an increasing degree must be on structuring the educational experience in a way which encourages the student himself to get to the point of self-sufficiency or independence in educational terms, to the point where he can continue his own education in informal ways outside the formality of a structured curriculum. . . . The importance of [this goal] becomes underscored as the rate of change in technology and the amount of information increase."

◇ What about Dr. Wiesner's sometimes controversial positions on public issues which interface with science? Asked at the press conference on March 5, Dr. Wiesner proposed that "on issues that I feel strongly about I will undoubtedly want to speak out. But I also feel," he added, "that as President of the Institute I'll be a leader of a large community and I have to take into account the feelings and views of the whole community."

The Tech

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VOLUME 91, NUMBER 91 FRIDAY, MARCH 5, 1971 MIT, CAMBRIDGE, MASSACHUSETTS FREE

WIESNER NAMED PRESIDENT

MIT Provost Jerome Bert Wiesner will be named the thirteenth president of MIT today, according to highly reliable sources.

His name will be recommended to his Corporation at its quarterly meeting, scheduled for 10:00 this morning.

Wiesner was the selection of both the faculty committee on the presidency and the Corporation Joint Advisory Committee, and was approved by the Corporation Committee on the Presidency, chaired by James Fisk, a Corporation member.

His name was cleared through Administration and Corporation channels last week.

Wiesner will take office when current President Howard Johnson officially resigns in June of this year.

A special faculty meeting is being called at the request of the President, and will be held in Kresge Auditorium at 12:30 today. The Faculty Council will meet briefly prior to the full faculty meeting. They are set for an 11:55 meeting in the Emma Rogers Room.

The Corporation meeting will be resumed in the afternoon at 2:00 pm and the Alumni Association Board of Directors will meet at 5:30 at the Faculty Club.

Dr. Wiesner became Provost of MIT on July 1, 1966, and his current duties are as the senior academic officer reporting to the President; he also has responsibility for the interdisciplinary activities of the Institute's five schools.

Dr. Wiesner returned to MIT in 1964, after having been Special Assistant for Science and Technology to the President of the United States for three years. On his return, he became Dean of the School of Science and was responsible for seven academic departments -- Biology, Chemistry, Geology and Geophysics, Mathematics, Meteorology, Nutrition and Food Science and Physics.

Prior to his appointment by President Kennedy, Wiesner was Director of the Research Laboratory of Electronics, one of the largest interdisciplinary laboratories at MIT. Wiesner is fifty-five years old, and hails from Detroit, Michigan.

Secrecy has shrouded Wiesner's name for the last week, and no students were told of the Fisk Committee's decision. A press conference to announce both his selection and that of Paul Gray is tentatively set for 1:30 this afternoon in room 37-252. A conference for student con-

JEROME WIESNER

Jerome Wiesner, new MIT President

cern has also been scheduled for 4:00 this afternoon.

Both Johnson and Wiesner are expected to address the faculty this noontime, but it is not known whether or not outsiders will be permitted to attend the meeting. Presumably, the intent was to tell the faculty first, and then hold the news conference an hour later, so the meeting may be closed.

Reportedly, Wiesner will answer questions at the faculty meeting and the press conference, and will outline at that time what he sees as the real educational challenges on which he would like to work.

Gray selected 'chancellor'

Doctor Paul Edward Gray has been named Chancellor of MIT, a newly designated position.

Professor Gray's duties will include seeking innovative ways to improve undergraduate education and student-faculty contact, especially during the student's final two undergraduate years. Additionally, he will be responsible for expanding educational opportunities for blacks and other disadvantaged minority students.

Gray has been considered a leader in educational reform and curriculum development.

Gray is presently Dean of the School of Engineering, a post he assumed in January of this year. His predecessor, Raymond Bisplinghoff, resigned to become the Deputy Director of the National Science Foundation.

Prior to becoming Dean of Engineering, Gray was Associate Provost under president-elect Jerome Wiesner. In this capacity, he served as Wiesner's assistant and as administration spokesman during the occupation of the President's office.

A great deal of speculation surrounded Paul Gray during the early days of the search for Howard Johnson's successor. Many felt that Gray was removed from consideration for further promotion for some time when he assumed the post of 3 Engineering Dean. His appointment as Chancellor strikes some observers as an expression of the Corporation's confidence in the Wiesner-Gray administrative team.

Gray is an authority on semiconductor electronics and circuit theory. He is also the author of a widely used textbook on the subject. He received his S.B. in 1954, S.M. in 1955, and his Sc.D. in 1968, all from MIT.

THE TECH

Staff for this special issue: *Harvey Baker, Robert Elkin, Joe Kashi, Tim Kloepfer, Alex Makowski, Pete Peckarsky, Steve Rosensky.* Printed by *Robert Wiener, LSC Press.*

Members of the M.I.T. Corporation, arriving at the President's House on March 5 to hear—and presently approve—their Committee's nomination for the Institute's new President and Chancellor, found their task already done; The Tech *awaited them with an "extra" speculating —almost without error—on their choices. The editors were, of course, protecting their sources; but it is clear that their advance knowledge resulted less from any "leak" than from circumstantial evidence assembled during long hours of patient stake-outs. With the passage of time, the anger and chagrin first felt by many administration officials melted into a warmer recognition of* The Tech's *accomplishment as symbolic of intense student interest in the choices.*

Question to Dr. Wiesner (right) at the press conference: "Is it true that you are going to give up pipe smoking?" "It depends on the situation that I find myself in." Dean Gray (left): "I think it's more likely that I'll take it up."

The Press Conference: Conversion, Education, and Pipe Smoking

The following are excerpts of questions and answers at a press conference held at M.I.T. on March 5 to introduce Jerome B. Wiesner as President-Elect and Paul E. Gray, '54, as Chancellor-Elect of M.I.T.:

Q. to Dr. Wiesner: Do you expect to be continuing to speak out as an individual on such issues as disarmament and the war in Indochina?

Dr. Wiesner: I suspect I won't have the time that I've had in the past to be involved in that kind of activity, but I do feel that on issues that I feel strongly about I will undoubtedly want to speak out. I also feel that as the President of the Institute I'll be a leader of a large community, and I have to take into account the feelings and views of the whole community; and this makes me feel that I should not be involved as I have been in the past in partisan politics.

Q. to Dr. Wiesner: Do you have any plans for M.I.T.?

Dr. Wiesner: I have been involved for the past seven years in one aspect or another of the management of M.I.T. and so I'm fully aware of where it's going and what its problems are. I've had a strong hand in shaping many of the decisions that involve what we're doing now and where we're trying to go, so I don't see that there is a call for any major change in direction.

Q. to Dr. Wiesner: Can you tell us what are some of the immediate problems and challenges that M.I.T. faces?

Dr. Wiesner: Every academic institution in the country today—like practically every other institution including local, state, and federal governments—has a financial problem; this is no secret. Trying to adjust ourselves and to find new sources of income will be a major task in the period ahead, and I certainly will be involved in that.

Q.: Is the financial situation at M.I.T. critical, or how do you see it?

Dr. Wiesner: We like every other institution are living with an inflation, which means that costs are going up very rapidly. Unlike businesses who feel quite free to push all their costs off on their customers, we find that it is just wrong to let the cost of an education rise as rapidly as it would if we didn't take steps to try to control it.

A second equally important problem is that institutions like ours—and ours in particular that has been a leader in science and technology and the evolution of our society—have to find the way to the future, and this is an important concern of the faculty here and of the students. A good deal of questioning is going on about the way to use science and technology in the most beneficial manner, and that certainly is going to be a key problem, as we move ahead.

Q. to Dr. Wiesner: How would you tend to cope with student unrest here at M.I.T. in the future?

Dr. Wiesner: Paul Gray has been involved with me in this.

Dean Gray: We've tried in the past to respond to the relatively few instances of student protest by being flexible and by recognizing that the dissent as expressed has generally involved a group in which only a small minority are M.I.T. students and so does not reflect at all the view or the expectations of the entire student body. The keynote of what's been done in the past at M.I.T.—and I would expect it to continue in the future—has been to respond in a way that recognizes the variety of people involved, is flexible in nature, and does not in the process serve to polarize or alienate large factions of the community.

Dr. Wiesner: Another point is that not all student unrest is bad, of course. That is, students frequently are expressing feelings held by wide segments of society, and often they have pointed the way to better education and have focussed attention on issues that we should be concerned about. We've tried in the past and I hope we will always try to understand what's being said not only by the students but from every quarter.

Q. Can you define the distinction between the Chancellor and the President?

Dr. Wiesner: It's not easy to define at this stage because we have not been functioning in those capacities, but Paul and I worked together as Provosts. In general we—plus our other colleagues, and the President—work as a team whenever we have policy matters to be decided; and when there are ongoing jobs to be done we try to divide them up in such a way that we can be efficient, and I suspect that's what we will do in this new plan. For example, in the Provost's Office Professor Gray had responsibility for the whole range of undergraduate educational experimentation and innovation—keeping track of the quality of the program—and while I was concerned about it and we talked about it a good deal, he had that responsibility.

Q. to Dr. Wiesner: One of the chief problems that faces the country is conversion from a military to a nonmilitary scientific establishment. Do you foresee M.I.T. taking a role of leadership?

Dr. Wiesner: We have been trying to do that. We have been involving ourselves for a number of years in a variety of social and civilian activities, in the medical field, in pollution, and in the urban field, and we are committed to move very hard on those problems.

Dean Gray: May I add that a number of examples of that kind of change can be cited in the School of Engineering, where increasingly members of the faculty and students are coming together to work, often in interdepartmental and interdisciplinary ways, on a variety of problems that have direct social roots and rather immediate social consequences. I am thinking of problems in the areas of transportation, environmental quality control, energy resources allocation and energy policy, and matters related to construction and urban planning. These are all areas which have been represented at M.I.T. for a long time, but I think we are seeing, particularly in the School of Engineering, a resurgence of interest in the last year or

two. This represents an example of the way in which directions are changing and evolving.

Q. to Dr. Wiesner: In the past, I understand, there has been some problem in trying to achieve these goals because money hasn't been available in amounts necessary and there has been resistance from some quarters. Can you give us some idea as to how conversion can be achieved and what kind of plans you may have?

Dr. Wiesner: It is true that we have had difficulty finding adequate resources to do many of the things people want to do. For example, in the pollution field we have very strong groups in a number of departments who have been working for years, and their ability to move ahead and to make progress has been limited by our inability to raise funds to support them. But there is an increasing realization now, I think—on the part of government and on the part of industry—of the importance of these things, and we believe the funding problem is going to be easier in the future than it has been in the past.

Q. to Dr. Wiesner: What are some of the achievements that you would like to see for yourself and the Institute during your administration?

Dr. Wiesner: I haven't really formulated goals for the institution, but the principal challenge, it seems to us, is to continue to deserve the reputation that this institution has for leadership in education and research and public service, and that's an increasingly difficult problem as the problems grow more and more complex. But an institution like this is not made by its administrators; its quality is determined by its faculty and its students and what they do, and our job is to support them as best we can and to insure that we have the best possible faculty and that they are given the freedom and opportunity to do the things they want to do.

Dr. Gray: I'd like to add that, in the area of education, particularly undergraduate education, M.I.T. has in the last 10 years, and more strongly in the last five or six, made rather dramatic changes in the nature of undergraduate education in terms of the degree of flexibility afforded the students and in terms of the recognition of individual differences, which now can be accommodated in the curriculum to a much greater degree than previously. Those are trends which are necessary and appropriate for the kinds of students who come here—a very remarkable student body; I think they are trends which will continue, and I think that our focus in the years ahead to an increasing degree must be on structuring the educational experience in a way which encourages the student himself to get to the point of self-sufficiency or independence, to the point where he can continue his own education in informal ways outside the formality of a structured curriculum of a classroom. That's a goal that's always been there, but the importance of it is underscored as the rate of change of technology and of information in general increases.

Q: Dr. Gray, you are implying that the main thrust of what's been going on in the last few years is to try to develop ways in which the students can be self-sufficient. If that is so, perhaps you can just say something a little bit specific about how do you do that.

Dean Gray: There have been two thrusts. One has been to provide a greater number of alternatives in the curriculum. Only 11 or 12 years ago the freshman year at M.I.T. was totally structured, with just one program which all students took and no variation from individual to individual. What exists now is seven or eight alternatives in the humanities, four or five in each of the science areas—mathematics, chemistry, and physics. Freshmen this term are enrolled in upwards of 150 different subjects. That flexibility in curriculum will continue; it's a recognition of the fact that among the 1,000 young people who enter M.I.T. every year, there are more and more differences—differences in preparation, differences in interest, and differences in motivation. No single mode, no single style, no single curriculum is appropriate for the range that M.I.T. students represent, and we've got to develop alternatives that are attractive and available. The second thrust, the one I mentioned a moment ago, is that of trying to bring students early in their careers to the point where they find how to ask significant questions, as well as to answer them, how to formulate problems, how to deal with new and bewildering situations. One develops these abilities by things such as project laboratories, opportunities for independent study, experimental programs in the freshman year which put the emphasis on self-direction and collaboration between students and faculty, and undergraduate research opportunities which permit students to come into one-to-one contact with members of the faculty on a research basis. These things are examples of ways in which we've tried to bring students earlier rather than later to the point of self-sufficiency, self-renewal in educational terms.

Q: Dean Gray, what are the first things you're going to do in the office of Chancellor?

Dean Gray: Well, it's a little early for that question. I expect that Dr. Wiesner and I will spend a good deal of time in the next three or four months thinking through some of those matters, and it's really a bit premature now.

Q: Dr. Wiesner, aside from being a very fine university, M.I.T. is also a member of the Cambridge community, and certain of the citizen groups within the community have complained in the past that M.I.T. and Harvard are jointly responsible for the "housing crisis" in Cambridge. Do you have any comments on that?

Dr. Wiesner: It's certainly true that the growth of universities in the greater Boston area—I think it's not only M.I.T. and Harvard—has put pressure on housing, and we feel a responsibility for doing something about that. I am sure you are aware of the fairly major programs that M.I.T. has undertaken to construct housing, and we're hoping that we'll be able to do more. This is a very tough and complicated and costly problem to deal with, and resources are a continuing problem in an institution like this; but we have a commitment to which we will continue to give a high priority to help with this problem.

Dean Gray: At the same time as we are trying to increase housing resources in Cambridge generally we are also trying to increase the availability of residential facilities on campus. There has been an increase in the number of rooms available to undergraduates, and there is at present under construction on the West Campus a new graduate student housing facility which we hope will relieve some of the pressure as well.

Q: I understand that applications for admissions to M.I.T. have gone down considerably during the current year. What do you attribute this to?

Dean Gray: Your observation is correct. Applications for admission to next fall's freshman class are off by something in the range 18 to 20 per cent. I have no easy explanation for that. This is a phenomenon which we share with most of the other private universities including those with whom we compete for students.

Dr. Wiesner: And many public universities are having the same experience. When we first observed this we thought perhaps it was a turning away from science and engineering, but this is a very common phenomenon at many institutions. Whether it is a reflection of the economic situation, of changes in the draft laws, or a combination, we just don't know.

Institute Review

Doing Your Thing: Computers, Dancing, and Formula V Racing

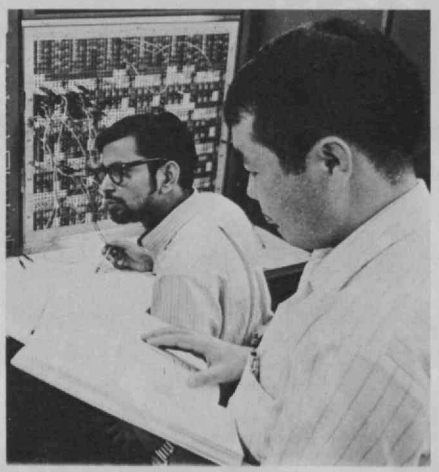
When M.I.T. settled down—in a manner of speaking—from the 1970-71 Christmas holidays, it was not to final examinations but to an orgy of "do-it-yourself" activities which left students literally free to do whatever interested them most, or nothing at all.

The January Independent Activities Period resulted from a change in the academic calendar adopted by the M.I.T. faculty last year; the first term was advanced and reading period shortened so that first-term final examinations could be completed before Christmas; and January was thus available for a three-year trial of the experimental "do-your-own-thing" program. A formal evaluation of the first year's experience is now under way by the faculty, and plans for next year will be developed on the basis of its results, according to Robert G. Gallager, Sc.D.'60, Professor of Electrical Engineering who was chairman of the faculty-student group which coordinated I.A.P. plans.

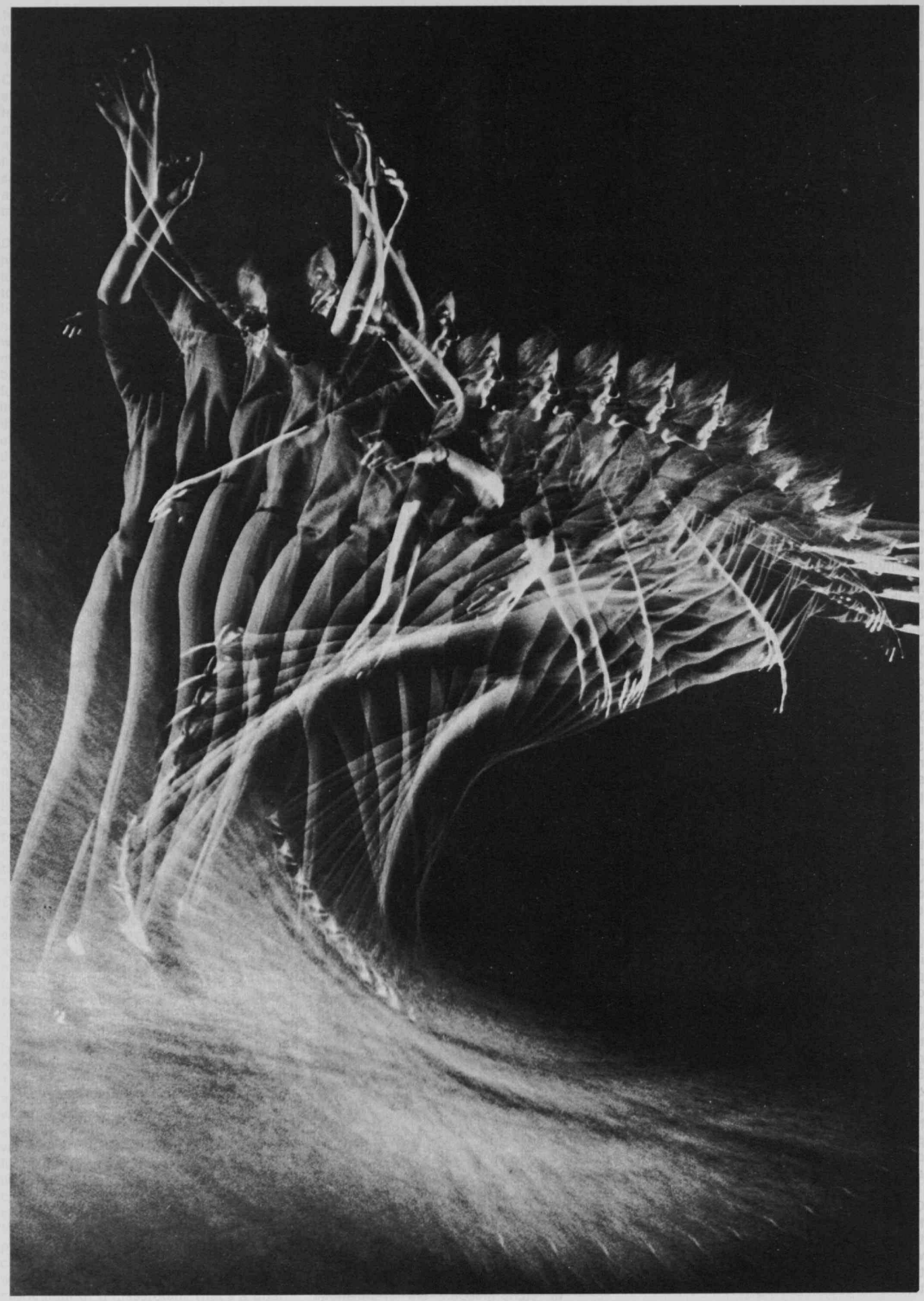
Early student reaction seemed enthusiastic. An informal census of campus residence halls and fraternities in mid-January indicated that more than three-quarters of all undergraduate and graduate students were back.

Literally everybody on the campus joined in organizing January programs and projects—academic departments, interdisciplinary centers, special laboratories, and students themselves. Some students used the time to make up work missed in the first term. Many graduate students continued their regular thesis research. But for most I.A.P. participants it was a chance to do what cannot be done under the academic pressures of a regular term. Most activities offered no credit, though pass/fail grading and up to six units of credit were possible in faculty-approved activities.

One benefit was closer association between students and faculty. With the need to get through a fixed body of course work eliminated, faculty members could take time to describe their research interests in detail. Visiting lecturers were



Independent activities—the announced program for the Independent Activity Period during January at M.I.T.—meant many things to many people, among them computer experiments, ceramics, co-educational fencing, and aerodynamics research. There were also more formal activities: remedial classes, make-up examinations, and an almost infinite number of seminars. (Photos: Donald L. Estes, '71)



The pictures on these pages resulted from a one-week course in high-speed photography conducted during M.I.T.'s Independent Activities Period by Harold E. Edgerton, Sc.D.'31, and Gjon Mili, '27, Life *photographer, whose first collaboration 40 years ago yielded modern methods of strobe photography. The students learned, for example, how to use two flash units to provide even, interesting lighting for a portrait of their two teachers while one was five feet further from the camera than the other (below). There were also lots of experiments with multi-flash pictures and reflectors, yielding—among many others—the picture opposite by George L. Clemmer, II, '73, which Mr. Mili calls "the best effort during the seminar." (Photos: George L. Clemmer, II, '73, Alan C. Efromson, '74, and David A. Townzen, '72, from* Technique)

included in many activities—for example, Gjon Mili, '27, *Life* photographer, who joined with Harold E. Edgerton, Sc.D.'31, Professor of Electrical Engineering, Emeritus, to give a one-week intensive course in high-speed photography.

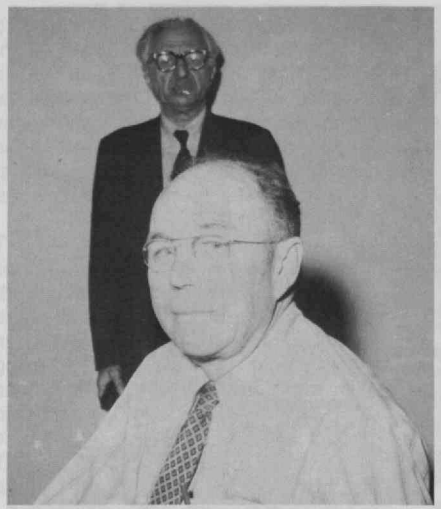
The Political Science Department sent several students with Professor Lincoln Bloomfield to the United Nations for three days to talk to senior diplomats and observe daily activities. Another group sponsored by Edwin Diamond, former Senior Editor of *Newsweek,* spent part of the month as observers in radio stations and newspapers in New York and Washington. One group of students started building a four-person, high-wing airplane. The project will continue during the spring semester.

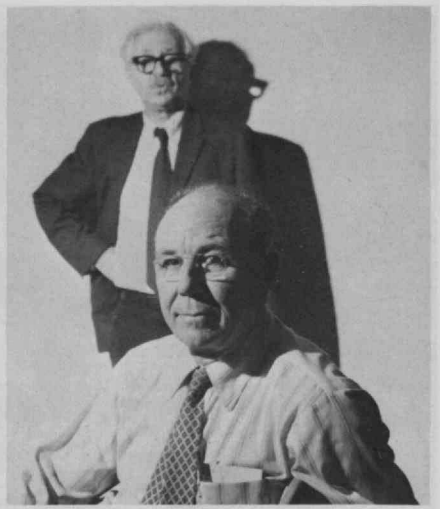
The Department of Architecture gave a subject called "Molten Architecture: the Structure and Space of Baroque Music," with enrollment limited to players of baroque instruments. Taking a nuts-and-bolts approach, the Department of Urban Studies and Planning presented a series of workshops on such topics as housing programs and policies, zoning law, and grantsmanship.

Lincoln Laboratory and the Department of Earth and Planetary Sciences collaborated to present "A Short Course on Earthquakes and Explosions," for students without prior study in geophysics. There was also a brilliantly successful lecture series on current research topics in geology, astronomy, and meteorology. For students lured by the sea, the Department of Naval Architecture and Marine Engineering offered a course on the history of ships and seafaring.

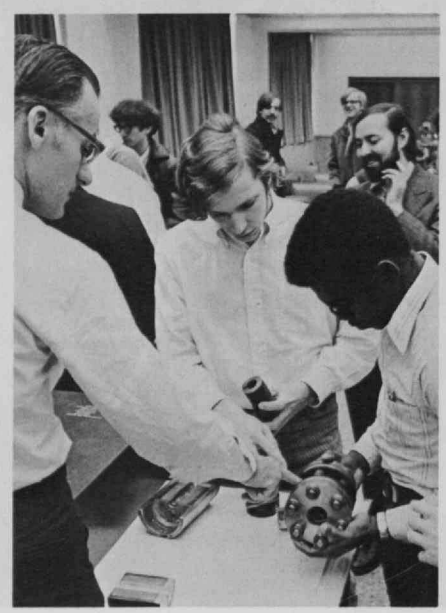
Two graduate students organized a group to design creative toys and teaching aids for first- and second-grade children in cooperation with an elementary school in Boston.

The M.I.T. Dramashop used the I.A.P. to prepare a "1970's jet-set" production of *The Merchant of Venice* for performance in mid-February. A second group of students did an in-depth study of the play during its preparation. Another peek into history was offered by the Physics Department where lecturers attempted to





An unusual Independent Activities Period feature was a one-week "short course" for undergraduates at the Bitter National Magnet Laboratory. It provided a unique opportunity to see—and, in some cases, use—magnets ranging from the world's most powerful to the compact miniatures at the lower right. (Photos: Donald L. Estes, '71)



recreate the mood as well as the content of a Renaissance classroom, giving presentations on celestial mechanics and alchemy. "How Theories Are Made: Happy and Sad Case Histories," the title of a seminar series also in the Physics Department, became even more interesting with imaginative subtitles such as "Comedy of Errors: Relativistic Schroedinger Equation."

Computer courses offered by many departments were very popular. The Francis Bitter National Magnet Laboratory—a highly specialized research facility which most students simply lack time to explore during the regular terms—gave a five-day short course on "The Marvels of Magnetism and Magnets," opening the entire Laboratory to sightseers and experimenters.

The Electrical Engineering Department offered many extensions of its regular subjects, and also arranged a remarkable array of special activities including a lunar surface study, preparation for the General Class Amateur Radio License, and a laboratory where students could compose electronic music.

Some activities turned up in unexpected disciplines; for example, a seminar on Formula V race car design in the Department of Aeronautics and Astronautics and a short course on investing in the stock market in the Department of Mechanical Engineering.

The student art association was a multimedia happening with painting, clay work, batik and weaving, jewelry making, etching, photography, and stained glass work. One student organized beginning classes in classical and Flamenco guitar.

The Sloan School of Management ran a one-week intensive sensitivity training program which enrolled more than 80 students.

Pollution problems were tackled by many groups, including the interdepartmental environmental projects laboratory which had a computerized game-type air pollution control management model.

A student committee for better transit spent part of the month drawing up plans

Westgate II, now under construction at the extreme west end of the M.I.T. campus, will accommodate more than 400 graduate students—but can be converted from dormitory to apartment house if and as needs change. Part of its funding was included in the proceeds of the Institute's first bond issue, made in November through the Massachusetts Health and Educational Facilities Authority.

for an experimental closing to automobiles of a portion of Newbury Street in the Boston Back Bay retail district.

Westgate II

Ground was broken early in March for Westgate II, a 24-story tower at the west end of the M.I.T. campus to house more than 400 graduate students. The new building will complement other Westgate facilities—a tower and several low-rise buildings—which are now occupied by married students.

The new tower will be divided into two-student, three-student, and four-student apartments, each one to include a living room, dining area, single study-bedrooms, kitchen, and bath. Though initially planned for use by single students, the apartments have been designed so that they can be converted in part or entirely into one- and two-bedroom units suitable for married students or young faculty, should future needs require.

Community facilities, located on the first and 24th floors of the new building, will include laundry, mail and parcel rooms, other service spaces, and a manager's office. The tower will have a structural steel core with exterior frame and window wall of precast concrete—in contrast to the Westgate I tower, which is a poured concrete frame. The architects are Hugh Stubbins and Associates, structural design is by LeMessurier Associates, Inc., and mechanical design by Hankins and Anderson Associates. Completion is scheduled for September, 1972, and the cost is estimated at $7.5 million, of which $6 million represents proceeds of a bond issue arranged under the Massachusetts Health and Educational Facilities Authority (*see* Technology Review *for January, pp. 99-100*); $1.5 million will be provided from unrestricted funds of the Institute.

Heating and Chilled Water Plants

The expansion of the Institute's heating plant made possible through funding under the Massachusetts Health and Educational Facilities Authority will include an extension to the building in which it is housed and the addition of one 100,000 lb./hr. boiler; space in the new building will remain for two similar additional boilers to be added when demand requires. The expansion will satisfy present heating demand with adequate reserve against equipment failure and provides capacity for campus expansion in the near future.

The chilled-water plant, a central air-conditioning facility located adjacent to the Institute's power plant, will be expanded with a 3,500-ton compressor and the associated cooling towers together with fuel storage tanks, pumps, and other necessary equipment. It will provide sufficient air-conditioning capacity to satisfy near-future demand. The project also includes a substantial addition to fuel storage capacity.

Skidmore, Owings & Merrill of Chicago is architect for the heating and chilled-water plant expansion, the total cost of which will be over $4.6 million. Completion of the heating plant is scheduled by July, 1971, and of the chilled-water facilities July, 1972.

Visiting Teachers at M.I.T.

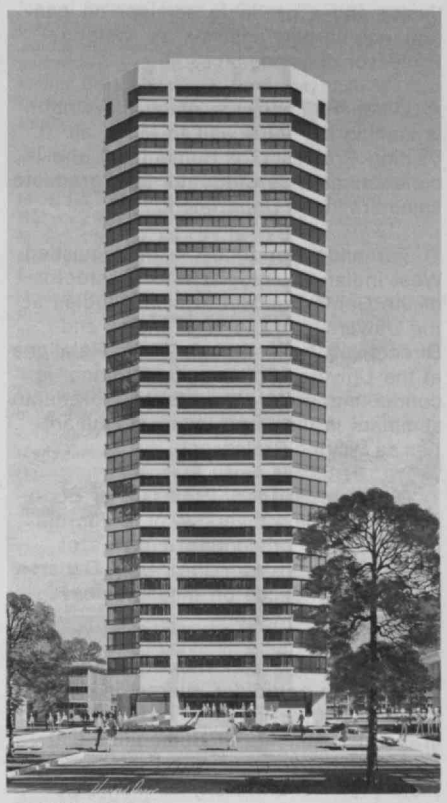
A roster of 13 distinguished guests are serving as visiting professors and lecturers in the M.I.T. Schools of Humanities and Social Sciences and of Management during the current year. The list:

◇ William A. Arrowsmith, formerly Chairman of the Classics Department at the University of Texas, is teaching an elective course in Sophocles, Euripides, and Aristophanes in the Department of Humanities and serves as a consultant to the Commission on M.I.T. Education.

◇ Michael Bruno, Professor of Economics at Hebrew University, Jerusalem, Israel, is a Ford Foundation Faculty Research Fellow in the Department of Economics, teaching at both M.I.T. and Harvard.

◇ William P. Bundy, former Assistant Secretary of State for Far Eastern Affairs, is in his second year as a Senior Research Associate at the M.I.T. Center for International Studies.

◇ Edwin Diamond, a newspaperman



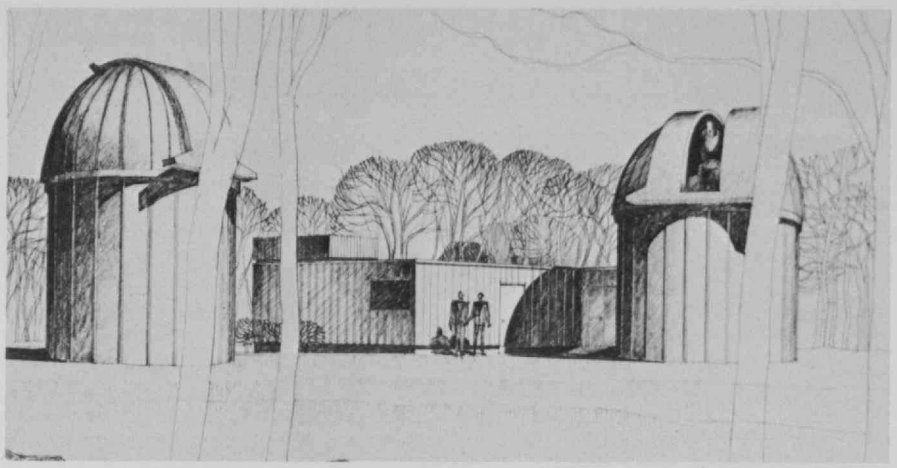
with experience on the *Chicago American,* the *Washington Times-Herald,* and International News Service before he joined *Newsweek* as Science Editor and later Senior Editor, is a Senior Fellow in the Department of Political Science. He is teaching a group of students interested in journalism.

◇ Jerome I. Elkind, '52, Senior Vice-President of Bolt, Beranek and Newman, Inc., is teaching management during the current year as a Visiting Professor at M.I.T.'s Sloan School.

◇ Daniel Ellsberg, formerly an economist with the Rand Corporation, Department of State, and Department of Defense, is serving as Senior Research Associate at the Center for International Studies.

◇ Frank H. Hahn, Professor of Economics at the London School of Economics and Fellow of Churchill College, Cambridge, is teaching an undergraduate course on intermediate micro-economic

A gift from George R. Wallace, Jr., '13, is making possible construction of M.I.T.'s first optical observatory on a site in Westford, Mass. Despite the Institute's leadership in radio and radar astronomy—due in part to special facilities of the Lincoln Laboratory, including notably the Haystack radio antenna—M.I.T. has never before had an optical instrument. The new facility, with 16- and 24-inch telescopes, is due to be completed in the spring.



theory and a graduate seminar on general equilibrium analysis as Visiting Professor of Economics.

◇ Lillian Hellman, the noted playwright, is making her third visit to M.I.T. as Visiting Professor of Humanities; she is conducting undergraduate and graduate seminars in the Department.

◇ Fernando Henriques, a distinguished West Indian sociologist who is Director of the Center for Multi-Racial Studies at the University of the West Indies and Director of the Institute of Race Relations at the University of Sussex, England, is conducting undergraduate and graduate seminars in the Department of Humanities as Visiting Professor.

◇ Daniel McFadden, Professor of Economics at the University of California (Berkeley), is presenting a series of graduate lectures for the M.I.T. Department of Economics on measurement in microeconomic theory.

◇ Ernst Nolte, a historian of modern Europe with particular interest in diplomatic history, is Visiting Ford Professor in the Departments of Humanities and of Political Science; he is Professor of History at the University of Marburg, Germany.

◇ Carl Oglesby, a Visiting Lecturer in the Department of Humanities this year, has been associated with the Center for the Study of Democratic Institutions at Santa Barbara, Calif., and the Aspen (Colo.) Institute for Humanistic Studies; he was President of Students for a Democratic Society in 1965-66.

◇ Sidney Peck, Visiting Lecturer in Humanities this year, is Associate Professor of Sociology at Case Western Reserve University.

Information Services

Following the retirement late in 1970 of Francis E. Wylie, Director of Public Relations, M.I.T.'s information activities are being reorganized into the Institute Information Services, according to Constantine B. Simonides, Vice-President. Robert M. Byers, formerly Associate Director of Public Relations, has been named Acting Director of the new three-pronged I.I.S. activities; and Paul W. Johnson, formerly associated with the office of the Vice-President and Secretary of M.I.T. and more recently Director of Management and Development for Massachusetts Half Way Houses, Inc., has returned to M.I.T. as Associate Director.

Relationships with public media will be centered in the newly organized M.I.T. News Office, of which Mr. Byers is Director. Official Institute publications will continue under the Publications Office and community information under the Campus Information Office. In connection with the new plan, John G. N. Rushbrook and Joanne Miller, both formerly associated with the M.I.T. Office of Public Relations, have been named Assistant News Directors; Miss Miller will continue as Editor of *Tech Talk,* M.I.T.'s "house organ."

George R. Wallace Observatory: A New Step into Astronomy

Construction has begun on the $400,000 George R. Wallace, Jr., '13, Astrophysical Observatory—M.I.T.'s first optical telescope facility—on a hilltop site near the Haystack antenna in Westford, Mass. Its principal equipment will include a computer-controlled 24-inch telescope and a 16-inch instructional instrument, and James R. Killian, Jr., '26, Chairman of the Corporation of M.I.T., says it will fill "what has become a major and urgent need in the growing fields of astronomy and astrophysics at M.I.T."

Construction is made possible by a $300,000 gift of Mr. Wallace, who was for many years President of the Fitchburg Paper Co. and is known in central Massachusetts for civic and educational philanthropy; he has a long-standing interest in astronomy and in clear-air turbulence. "It is my great hope that the observatory will serve as a useful tool in advancing the education and training of students interested in astronomy and astrophysics and in making more effective the remarkable research in astrophysics that has taken place at M.I.T. in recent years."

Of particular scientific significance, according to Robert A. Alberty, Dean of the School of Science, is that the Wallace Observatory will be linked electronically with the Haystack radio telescope; the result, he said, will give M.I.T. astronomers and astrophysicists "one of the few optical/radio observatories in the world where simultaneous observations of the same celestical object can be made at both visible and radio wavelengths."

Thomas B. McCord, Assistant Professor of Planetary Physics, will direct the Wallace Observatory, and he will also serve as chairman of a steering committee on its operations. The Wallace 24-inch telescope will employ a unique integrated computer operation to achieve precision accuracy in sightings, to operate and monitor instrumented experiments (including those coordinated with the Haystack telescope), and to analyze experimental results. "Our plan is to have at the Wallace Observatory a built-in versatility that will permit a flexible range of activity from observation to instruction, including the testing of new instrumentation and new methods of data handling and analysis," Dr. Killian said.

Already astronomy is a popular subject at M.I.T., enrollment in astronomy courses jumped from 22 three years ago to 425 last year, and many students and staff have been using telescopes elsewhere to complete their research. Some will continue to use larger telescopes than those planned for the Wallace Observatory, but the Wallace facilities will permit experimental testing and calibration in advance and so save research time and funds.

Columbus O'D. Iselin, 1905-1971

Columbus O'Donnell Iselin, one of the world's foremost oceanographers who held a faculty appointment at M.I.T. for seven years following his service as Director of the Woods Hole Institution of Oceanography, died on January 5. He was 66.

Dr. Iselin first served as Director of the Institution from 1940 to 1950, following the retirement of Henry B. Bigelow, '00, its first Director. He returned to the Directorship during the International Geophysical Year from 1956 to 1958,

then resigned to devote more time to scientific studies and teaching assignments at Harvard and M.I.T. He was Professor of Physical Oceanography at M.I.T. from 1959 to 1966, and since 1958 he held the Henry Bryant Bigelow Chair of Oceanography at Woods Hole.

The first permanent staff member of the Woods Hole Oceanographic Institution in 1930, Dr. Iselin studied at St. Marks School and Harvard (A.B. 1926, A.M. 1928); his early studies of the Gulf Stream system have become "classics" in physical oceanography. He held the Medal of Merit, the highest U.S. award to civilians; the Agassiz Medal of the National Academy of Sciences, of which (at age 37) he was the youngest recipient; the Bigelow Medal of the Woods Hole Oceanographic Institution; and honorary degrees from Brown University and the University of Rhode Island.

Keyes Professorship

Frederick G. Keyes, Professor of Physical Chemistry, Emeritus, who is internationally known as a physical chemist and a pioneer in cryogenic research, has been honored by establishment of the Frederick George Keyes Professorship of Chemistry at M.I.T.

Dr. Keyes came to the Institute in 1910 as a research associate to work with Arthur A. Noyes, who was then Professor of Chemistry; he became Director of the Research Laboratory of Physical Chemistry following World War I and subsequently was Head of the Department of Chemistry from 1923 to 1945. He retired in 1950 but continues to play an active role in the research program of the Department and in Keyes Scientific Co., Inc., an industrial consulting firm based in Cambridge.

Dr. Keyes' research on the properties of steam at high temperatures and pressures led to his collaboration with Joseph H. Keenan, '22, Professor of Mechanical Engineering, Emeritus, in developing the Keenan-Keyes steam tables used throughout the world as the basis of modern steam generating plant design. Professor Keyes was also a leader in basic research on intramolecular forces and the physical properties of gases, and he played an important role in the design of the Eastman Laboratories, M.I.T.'s first building devoted to graduate research and education in chemistry and physics.

Dr. Keyes holds honorary degrees from Yale University, Rhode Island College, and Brown University; the Richards Medal (1942) of the Northeastern Section of the American Chemical Society; and the Medal (1948) of the American Society of Mechanical Engineers. He is a member of the National Academy of Sciences and of Sigma Xi.

Special Summer Programs

Plans for 52 Special Summer Programs—"short courses" intended for professionals who need to keep pace with new developments in their fields or who want to broaden their capabilities—to be conducted at M.I.T. in 1971 have been announced by James M. Austin, Sc.D.'41, Director of the Summer Session. Thirteen are in the field of management, 23 in engineering, four in nutrition and food science, and eight in applied science.

Complete details of all programs—for which tuition ranges from $330 to $800—are available from the Summer Session Office, Room E19-356, M.I.T.

The following programs are being planned:

Chemical Engineering:
New Developments in Modeling, Simulation, and Optimization of Chemical Processes, Lawrence B. Evans, June 22-July 1, $450.
Analysis of Crystallization Systems, Geoffrey Margolis, Sc.D.'69, August 2-11, $450.

Civil Engineering:
Analysis and Design of Transportation Systems, A. Scheffer Lang, '49, and others, August 16-27, $520.
Soft Ground Construction, Charles C. Ladd, '55, and others, August 23-September 1, $450.
Fiber-Reinforced Composite Materials, Frederick J. McGarry, '50, July 19-23, $350.
Engineering Aspects of Heat Disposal from Power Generation, Donald R. F. Harleman, Sc.D.'50, June 28-July 2, $350.
Systems Building and Industrialization in the U.S., Albert G. H. Dietz, '32, June 28-July 2, $350.

Communication Systems and Technology:
Detection, Estimation and Modulation Theory (two parts), Harry L. Van Trees, Jr., Sc.D.'61, and others, June 14-18 and 21-25, $350 each part, $600 combined.
Application of State-Variable Techniques to Communication Systems, Harry L. Van Trees, Jr., Sc.D.'61, and others, June 21-25, $350.
Principles of Optical Communication, Robert S. Kennedy, Sc.D. and others, June 8-18, $520.

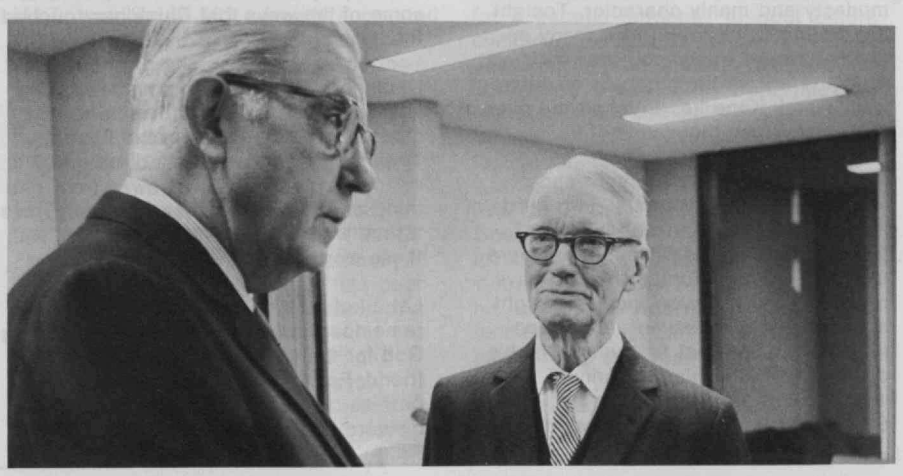
Nuclear Engineering:
Nuclear Power Reactor Safety (three parts), Norman C. Rasmussen, Ph.D.'56, July 6-9, 12-16, and 19-23, $350 each part, $600 two parts, $850 three parts.
Nuclear Fuel and Power Management (two parts), Edward A. Mason, Sc.D.'50, August 2-6 and 9-13, $400 first part, $750 two parts.

Other Engineering Subjects:
Strain Gage Techniques, William M. Murray, July 12-16, $330.
Two-Phase Flow and Boiling Heat Transfer, Peter Griffith, Sc.D.'56, and others, July 12-16, $330.
Controlling Brittle and Ductile Fracture in Metals and Composites, Regis M. N. Pelloux, Sc.D. and others, August 2-13, $520.
Interface Phenomena—Catalysis, Corrosion, Absorption, Electrochemistry—as Related to Biological Systems, Harry C. Gatos, Ph.D.'50, and others, August 16-27, $520.
Amorphous Semiconductor Devices, David Adler and others, June 28-July 2, $350.
Marine Decisions Under Uncertainty, John W. Devanney, III, '62, and others, June 28-July 2, $330.

Management:
Industrial Dynamics: Corporate and Social Systems, Carl V. Swanson, '60, June 8-18, $800.
Human Effectiveness in Today's Organizations, M. Scott Myers, June 13-18, $650.
Management of Human Resources, Jay R. Galbraith, August 29-September 3, $650.
Models for Financial Management and Long-Range Planning, Gerald A. Pogue and others, June 14-25, $800.
Investment Management and Analysis, Myron S. Scholes, July 12-23, $800.
Introduction to Computer Technology: Programming and Systems, William A. Martin, '61, August 2-13, $800.
Management Information Systems, John F. Rockart, Ph.D.'68, and others, August 16-27, $800.
Systems Simulation and Modeling, Malcolm M. Jones, '57, August 16-20, $500.

Organization and Planning:
Project Management—Organization and Planning, Wallace B. S. Crowston, S.M.'59, August 23-27, $400.
Inventory Control Systems, Wallace B. S. Crowston, S.M.'59, August 23-27, $400.
Management Science in Marketing, Alvin J. Silk and others, August 16-27, $800.
Dynamics of Health Service Systems, Edward B. Roberts, '57, June 28-July 2, $400.
Management of Research and Development, Edward B. Roberts, '57, August 16-27, $800.

Applied Science:
Infrared Spectroscopy (two parts), Richard C. Lord, June 21-25 and June 28-July 2, $330 one part, $550 two parts.
Cooperative Phenomena and Phase Transitions, H. Eugene Stanley, June 21-25, $330.
Biomedical Physics and Biomaterials Science, H. Eugene Stanley, June 28-July 2, $330.



Announcing the Frederick George Keyes Professorship at a reception honoring Professor Keyes (right) on the 60th anniversary of his association with the Institute, James R. Killian, Jr., '26, Chairman of the Corporation, said it was "an expression of our esteem for his distinguished career and of our appreciation for his many different kinds of contributions to M.I.T."

Generation and Application of Magnetic Fields, Brian B. Schwartz, July 12-16, $330.
Lasers and Optics for Applications, Shaoul Ezekiel, S.M.'64, July 19-30, $520.
Physical Aspects of Nuclear Medicine, Gordon L. Brownell, Ph.D.'50, and others, July 26-30, $330.
Topics in Neutron and Light Scattering, Sow-Hsin Chen and others, June 14-18, $330.

Nutrition and Food Science:
Enzymes and Their Use in Analysis and Clinical Diagnosis, Samson T. Jacob and others, July 12-16, $350.
Fermentation Technology, Daniel I. C. Wang, '59, August 23-27, $330.
Food Safety, Steven R. Tannenbaum, '58, June 28-July 2, $330.
New Processes for Food Concentration, Samuel A. Goldblith, '40, August 16-20, $330.

Economics and Decision-Making:
Forecasting with Econometric Models, Gordon R. Sparks, August 23-September 3, $550.
Models for Decision-Making Under Uncertainty, Alvin W. Drake, '57 and others, August 16-27, $550.
Design and Analysis of Scientific Experiments, Harold A. Freeman, '31, and others, July 12-23, $520.
Communicating Technical Information, Robert R. Rathbone, August 23-27, $330.

Henry B. Kane, 1902-1971

Henry B. Kane, '24, known to thousands of M.I.T. alumni as Director of the Alumni Fund from its inception in 1940 until his retirement in 1966, died at his home in Lincoln, Mass., on February 12. "Chick" was 69.

In 25 years of service to M.I.T., Mr. Kane's talents were manifest in many contributions to community life and communications as well as in the increasing success of the Alumni Fund. His wit and sensitivity gave warmth to the entire breadth of alumni affairs; his drawings have been a welcome feature in more than 25 volumes of *Technology Review* and in many Institute publications as they were in *Voo Doo,* the undergraduate humor magazine, during his student days; his steins designed for the annual alumni banquets are collectors' items; and his books in natural history are known throughout the world.

Born in Cambridge, Mr. Kane came to M.I.T. from Phillips Exeter Academy and following graduation joined the Boston Edison Co., first as an illuminating engineer and then in the advertising and promotion department. He was called back to the Institute in 1940 by Karl T. Compton, then President, to develop plans for annual alumni giving. More than $11 million was contributed to the Alumni Fund while under Mr. Kane's direction—making it one of the nation's largest—and it received a number of national awards. Thousands of alumni came to appreciate Mr. Kane's dedication to the Institute, his knowledge of its affairs, and the warmth of his relationships. Fewer—but remarkably many—came to appreciate the depth and constancy of his friendship. He was Secretary of his class for 21 years.

A keen naturalist, Mr. Kane combined his talents as artist, photographer, and writer into a collateral career to which he devoted full time following retirement. The results were a number of dis-

In Appreciation of Henry B. Kane

The following is the text of a tribute delivered by Donald P. Severance, '38, Executive Vice-President of the M.I.T. Alumni Association at the Alumni Advisory Council on Monday, February 22, 1971

Henry B. Kane, first and long-time Director of the Alumni Fund, died suddenly—but not unexpectedly—on Friday, February 12, 1971. To pay tribute to Chick is not easy. Chick was an *individual;* he fit no stereotype. He was a very personal individual, and for those of us who knew him well our attachment to Chick was close and very personal. But the overriding constraint is that every one of Chick's friends knows he would have been horrified at the thought of being eulogized. In fact, when asked that I speak to you of Chick, the thought that first flashed through my mind was Tennyson's *Crossing of the Bar:* "And may there be no moaning of the bar/ When I put out to sea."

Many of you may recall that the *Meditations* of Marcus Aurelius opened with a tribute to his grandfather from whom he learned good morals and government of his temper, and to his father from whose reputation and remembrance he learned modesty and manly character. Tonight my thoughts are not on how many individuals have influenced *me;* my thoughts are on the numbers of different ways Chick Kane has touched the lives of thousands upon thousands of us.

I think initially of the Alumni Fund of which he was first Director. Two-thirds of his 26 M.I.T. years he was not only Director, but he and his secretary *were* the entire Alumni Fund staff. You have heard the story. Seven thousand eight hundred and sixty-seven alumni contributed $64,000 that first year. Chick's opening words in his first Annual Report were: "Wars are not won by the General Staff. They lay the plans, they provide the ammunition, they point out the objectives, but all their work goes for naught without the backing of the foot soldier. It is he who carries through, who wins or loses the campaign."

In a mere three years, the M.I.T. Alumni Fund grew to be the fifth largest in the country. When Chick retired in 1966, the Fund exceeded $2,000,000. That year, three classes exceeded that $64,000 total of the first year's Alumni Fund. Alumni had contributed about $11,000,000 through the Alumni Fund during his tenure. As you know, we face a goal of $3,100,000 and 22,222 contributors for this year—an impressive monument to Chick's dedication to M.I.T.

There was another side to Chick. Bless him, he helped us laugh at ourselves: his "history"—*M.I.T. In The Twenties*—his cartoons in Alumni Fund mailings and monthly in *Technology Review,* and on the Alumni Day steins—thousands of drawings. In fact, the day he died he was working on a series of lighthearted drawings, a sort of "This Is Your Life" of Jim Killian. Chick's humor was always *fun* humor. Yes, it could be sharp; it could be keen. But *never* biting, *never* cutting. He would help us laugh at ourselves, but never, never laugh *at us.*

And too, Chick was far more than cartoonist, as is attested by his illustrations of children's books and nature books. Chick got up with the birds and went to bed with the birds. Nights of the Alumni Council meetings were the primary exceptions. No, this was not a case of his devotion to duty. This was yet another facet of Chick which touched on the lives of thousands; Chick, the naturalist. Whether it flew, ran, or flowered, Chick could draw it with precision or capture it by camera in the most skillful and pleasing of wildlife portraiture.

In addition to the hundreds of thousands, young and old, who have been pleased by his books, his nature pictures and his drawings, there have been a handful who have shared with Chick trips to Hudson's Bay or a Vermont beaver pond, when he was far more interested in picking and cooking fiddleheads than in fishing, or the tutoring of youngsters for school nature projects. These are indicative of some of the ways that Chick has touched the lives of thousands.

Chick in his own quiet way a few weeks ago wrote us his farewell when he concluded his Class Notes in the February *Technology Review:* "Lots of us find it difficult to tear ourselves away from one thing or another, but there always comes a time when it is inevitable. And so, with these words, goodbye."

Let all of us who knew Chick continue to remember him in our own ways, thanking God for the privilege of having him as a friend. For myself, I shall remember him best as one who never wronged a man by word or deed.

tinguished nature books, including *The Tale of a Meadow, The Tale of the Pond, The Tale of a Wood,* and—most recently—*Four Seasons in the Woods.* He provided illustrations and an informal collaboration in the "Cache Lake Letters" published for a number of years by John J. Rowlands, then Director of the M.I.T. News Service, which were later collected and expanded into *Cache Lake Country.* He also illustrated many other works, including several volumes of Henry Thoreau's writing, John Kieran's *Natural History of New York City,* Wyman Richardson's *House on Nauset Marsh,* and David McCord's *For Me To Say.* Mr. Kane was active in writing and drawing until the day before his death.

Mr. Kane is survived by his wife, the former Elizabeth Chapman; his sister, Mrs. Ethel Thomas of Hamstead, N.H.; two daughters, Mrs. Thomas Chaffee of Sheffield, Mass., and Miss Electa Kane of Maynard, Mass.; a son, David, of Liberty, Mo., and three grandchildren. Funeral services were private, and the family asked that memorial gifts be made to the M.I.T. Alumni Fund through the Class of 1924.

Over $500,000 from Kodak

Grants totalling $516,750 have come to M.I.T. from Eastman Kodak Co.—$500,000 for modernization of the George Eastman Research Laboratories as part of the Institute's program to strengthen research and teaching in chemistry, an unrestricted grant of $6,750 and a $10,000 research grant to encourage graduate education and research at the doctoral level.

The unrestricted grant results from a program of aid to institutions whose graduates have joined Kodak within five years after graduation and who then complete five years of employment with the company.

M.I.T.'s George Eastman Research Laboratories honor the Kodak Co.'s founder, George Eastman—who, as "Mr. Smith" contributed funds which made possible the Institute's Cambridge campus in 1916—and were dedicated shortly after Mr. Eastman's death in 1932.

M.I.T. was one of 101 privately supported colleges and universities receiving unrestricted grants from Kodak during 1970; seven schools received capital grants, and a total of $292,000 was given by the company in research grants to graduate departments during the year.

Filling the Shrock Professorship

Frank Press, Head of the Department of Earth and Planetary Sciences, has been named Robert R. Shrock Professor of Earth and Planetary Sciences—the Professorship established by Mr. and Mrs. Cecil H. Green ('23) of Dallas, Texas, in honor of Professor Shrock (*see* Technology Review *for May, 1970, p. 103).*

The appointment was announced by Robert A. Alberty, Dean of the School of Science, at an M.I.T. reception on December 3 honoring Mr. Green and Professor Shrock on the occasion of the 20th anniversary of their association in education and research. Professor Shrock retired in June, 1970, after more than 30 years on the M.I.T. faculty. Their collaboration began with a cooperative summer program for M.I.T. students to work at Geophysical Service, Inc., the predecessor company of Texas Instruments, Inc., of which Mr. Green is Honorary Chairman; subsequently Mr. and Mrs. Green have made the generous gifts to M.I.T. which provided the Cecil and Ida Green Building for the Departments of Earth and Planetary Sciences and of Meteorology.

Dr. Press, whom Dean Alberty describes as "one of the world's leading geophysicists," came to the Institute to head the Department of Earth and Planetary Sciences in 1965, upon Professor Shrock's retirement from that post. Earlier, Dr. Press had taught at Columbia University following graduate study (M.A. 1946, Ph.D. 1949) there and then had been Professor of Geophysics and Director of the Seismological Laboratory at the California Institute of Technology.

Dr. Press was a member of the President's Science Advisory Committee from 1961 to 1964 and now is a member of the National Science Board following his appointment early in 1970. He has been widely honored for his contributions to geophysics and seismology and to understanding of the structure of the earth and moon.

Foundation Grants: Computers in Architecture, Uric Acid in Gout

Two grants announced this winter emphasize the diversity of M.I.T. research: $40,000 from the Graham Foundation for Advanced Studies in the Fine Arts, to support advanced work in computer-aided architecture; and $154,757 from the John A. Hartford Foundation, Inc., to continue a study of the effects of diet on the occurrence of gout.

The gout research, supported at M.I.T. by continuing grants of the Hartford Foundation, will now be aimed at testing for a genetic tendency to gout before clinical signs and symptoms develop. The work will be done by Nevin S. Scrimshaw, Head of the Department of Nutrition and Food Science; Vernon R. Young, Associate Professor of Physiological Chemistry; William M. Rand, Assistant Professor of Biostatistics; and Andrew J. Clifford, Research Associate. Gout is known to be linked with high levels of uric acid in the blood, and previous research by Dr. Scrimshaw and his associates has established that a tendency to gout can be determined by tests of uric acid reactions.

The Graham Foundation funds will support fellowships in computer-aided architecture; the fellows will have direct access to computing facilities in the Department of Architecture and will use these to explore whatever new applications are of special interest. Donlyn Lyndon, Head of the Department of Architecture, is now seeking fellowship candidates who have had both design training and experience with computers. The most important criterion for selection, says Nicholas P. Negroponte, '66, Assistant Professor of Architecture, will be that "the candidate have a desire to explore emerging frontiers of computer technology and apply them to new concepts in architectural design."

Four principles in ceremonies for the first Robert R. Shrock Professor in the Department (left), and Professor Shrock; Sciences: (above) Frank Press, the new Shrock Professor who is Head of the Department (left), and Professor Shrock; and (below) Cecil H. Green, '23 (left), donor of the Professorship, with Robert A. Alberty, Dean of the M.I.T. School of Science.

H. Meissner, '29

R. Lamson

Lammot du Pont Professor

Herman P. Meissner, '29, has been named the Lammot du Pont Professor of Chemical Engineering, a chair established by members of the du Pont family as a memorial to Lammot du Pont, '01.

Professor Meissner joined the M.I.T. faculty as Assistant Professor of Chemical Engineering in 1940, having previously served as a fellow in business administration from 1932 to 1933 and an instructor in business and engineering administration (1934 to 1936) and in chemical engineering (1938 to 1940). He received his Sc.D. degree following two years of graduate study at the University of Frankfurt am Main, Germany, in 1938.

Raymond L. Bisplinghoff, then Dean of the School of Engineering, described Professor Meissner as "a leading authority on industrial chemistry" in announcing the appointment. Professor Meissner is the author and co-author of numerous publications and books in the fields of thermodynamics and applied colloids, and he has just completed work on *Processes and Systems in Chemical Engineering* to be published later this year.

Chemistry Department Head

Glenn A. Berchtold, an organic chemist whose work has centered most recently on the synthesis and properties of organic compounds, has been named to head the Department of Chemistry for a five-year period beginning July 1, 1971. He succeeds John Ross, Ph.D.'51, who has declined a second five-year term as Head of the Department in order to devote more time to teaching and research.

Professor Berchtold came to M.I.T. as a postdoctoral fellow in 1959 and was appointed Assistant Professor in the Department of Chemistry in 1961. He served as the Department's Executive Officer from 1963 to 1966 and as its Acting Head from 1966 to 1967, and he was appointed Professor of Chemistry in 1969.

Professor Berchtold has been the recipient of two grants from the Alfred P. Sloan Foundation for studies of organic synthesis, and he is Senior Editor of the *Journal of Organic Chemistry*. A graduate of the University of Illinois (B.S. 1954), he studied for a doctorate in organic chemistry (1959) from Indiana University.

A graduate of Queens College in New York and M.I.T., Professor Ross taught at Brown University before returning to the Institute in 1966. He is known for pioneering work on the kinetic theory of gases and chemical kinetics.

Nicholas A. Milas, 1897-1971

Nicholas A. Milas, Associate Professor of Chemistry, Emeritus, died on January 25 following six months' illness. He was 73.

Reporting his death to the Institute community, President Howard W. Johnson said Professor Milas was "a world authority" on organic peroxides used in the production of both plastics and rubber. He directed important work on synthetics during World War II and later shifted his activities into the synthesis of Vitamins A and D and related products, on which he held a number of key patents.

Professor Milas was born in Crete and came to the U.S. in 1912; he studied at Coe College (B.S. 1922) and the University of Chicago (M.S. 1923, Ph.D. 1926) and came to M.I.T. as a research associate in organic chemistry in 1928. Professor Milas joined the faculty in 1935 and retired in 1962, but he remained active in professional work until 1970.

Class of 1922 Professor

Dr. Roy Lamson, Professor of English in M.I.T.'s Department of Humanities, has been appointed Class of 1922 Professor. Announcement of the appointment was made by Dr. Robert L. Bishop, Dean of the School of Humanities and Social Science.

As Class of 1922 Professor, Dr. Lamson succeeds Dr. Paul E. Gray, who after only recently becoming Dean of the School of Engineering, has now been named Chancellor of M.I.T. *(see pp. 89-94)*. The chair was established in 1962, on the occasion of the 40th reunion of the Class, with the expressed desire that its occupant "devote not less than 50 per cent of his time in teaching or in his preparation therefor."

Professor Lamson came to the Institute as a visiting professor in 1957 and was appointed professor in May, 1958. His special interest as a scholar is the English Renaissance, and he has written extensively on ballads and seventeenth-century music. Before coming to M.I.T., Professor Lamson was professor of English and dean of freshmen at Williams College, where he joined the faculty in 1938.

As chairman of the Northeastern Regional Committee which selects candidates for Marshall Scholarships, Professor Lamson was appointed by Queen Elizabeth II in 1969 as an Honorary Officer of the Order of the British Empire, for his services to Anglo-American friendship and understanding.

Astronomer Appointed

Gordon H. Pettengill, '48, Acting Professor of Astronomy at Cornell University and Director of Cornell's Arecibo Observatory in Puerto Rico, has joined the M.I.T. faculty as a Professor in the Department of Earth and Planetary Sciences.

Professor Pettengill has been associated since 1954 with the M.I.T. Lincoln Laboratory, where he has worked primarily on radar observations of moon and planets. He was on leave from 1963 to 1965 as Associate Director of the Arecibo Observatory and again since 1968 to be its Director. Following undergraduate work in physics at M.I.T., he completed graduate work for the Ph.D. in physics (1955) at the University of California at Berkeley.

Apollo 14's New Horizons

The notion that people go to the moon for the same reason that they climb an unclimbed mountain—because it's there—was reinforced by an episode that occurred during the Apollo 14 mission. The lunar module had landed about 3,500 feet from a crater called Cone Crater,

some 800 feet across and with its rim rising about 400 feet above the boulder-strewn Fra Mauro plain. Cone Crater was a major goal from the geological viewpoint, due to the possible great age of the rocks that might be found there, but module pilot Edgar D. Mitchell, Sc.D.'64, viewed the crater walls as a personal challenge as well.

Partway up the 18-degree slope, hauling their "modularized equipment transporter," Edgar Mitchell and Alan Shepard began to debate whether to turn back, in view of the shortage of time. Both were showing accelerated heart-rates and breathing. Reportedly, the dialogue went like this: *Mitchell:* "Let's head right for that boulder at the top." *Shepard*: "I don't think we'll have time to go up there." *Mitchell:* "Oh, let's give it a whirl. Gee whiz. We can't stop without looking into Cone Crater." *Shepard*: "I think we'll waste an awful lot of time travelling and not much documenting." *Mitchell:* "Well, the information we're going to find, I think, is going to be right on top."

At this point, the voice of Houston asked them to estimate where exactly they were (there being nothing to judge by except the astronauts' own eyes), and to use their own judgement. *Mitchell:* "Well, we're three-quarters there. Why don't we leave the MET (the transporter) and get on up there?" *Shepard*: "No, I think what we're looking at right here, this boulder field, Ed, is the stuff that is ejected from Cone." *Mitchell:* "But not the lowermost part, which is what we're interested in." *Shepard:* "OK, we'll press on a little further, Houston. And keep your eye on the time."

In fact, after further advice from Houston, the two turned back, about 150 feet from the rim. Dr. Mitchell was heard to remark "Sonofabitch!" on his way back to the lunar module.

Commander Edgar Mitchell is described by some at Houston as the most intellectual of the astronauts; his doctoral dissertation was "Guidance of Low-Thrust Interplanetary Vehicles." He is quoted as saying that his academic credentials "were planned with the space program in mind." His two bachelor's degrees are from the then Carnegie Institute of Technology (in industrial management) and from the U.S. Navy Postgraduate School (in aeronautical engineering).

New York Times reporter Sandra Blakeslee wrote of his fascination with "things that he, and other men, cannot understand"—notably, extrasensory perception. She quotes him thus: "I think we are learning and have learned that there is a great deal about the human mind, the human spirit, the essence of humanity, that is somewhat different from what we've thought in the past. To me, it is very similar to looking at space flights 15 years ago. It's a new horizon."

On the Apollo 14 flight, Commander Mitchell took with him a pack of test-cards of the kind used in extrasensory perception studies—25 cards, five each of five kinds—and conducted an experiment in conjunction with a Chicago psychic, Olof Johnsson. Somewhere between here and the moon, Commander Mitchell went through the pack in a random order, while Mr. Johnsson attempted to receive the order in which the cards came up. At this writing the results are not known, although Johnsson has reported that he was receiving loud and clear. Surely the furthest-out parapsychological experiment of all time, it was not sponsored by N.A.S.A.

Box Score for M.I.T. Astronauts

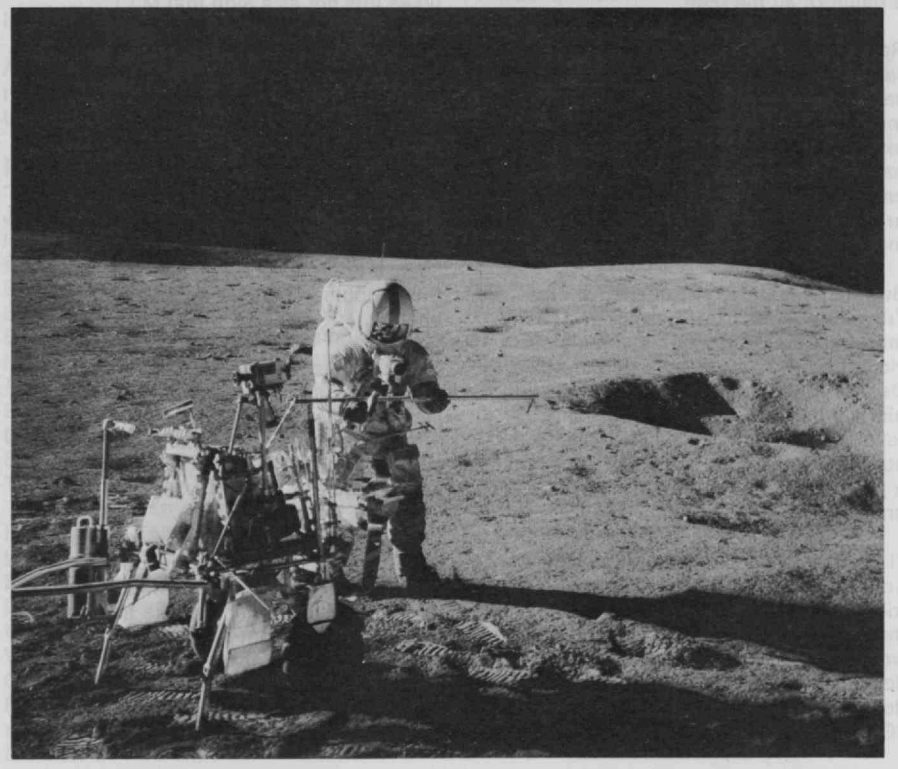
Navy Commander Edgar D. Mitchell, Sc.D.'64, lunar module pilot on Apollo 14—and one of the 19 astronauts selected by N.A.S.A. in April of 1966—was the fourth person to fly in space armed with a degree from M.I.T.

Other M.I.T. graduates who have flown in space have been Colonel David R. Scott, S.M.'62, Eng.'62, who was pilot on Gemini 8 and command module pilot on Apollo 9; Colonel Edwin E. Aldrin, Sc.D.'63, who was pilot on Gemini 12 and lunar module pilot on Apollo 11, becoming the second man on the moon; and Russell L. Schweikart, S.B.'56, S.M.'63, who was lunar module pilot on Apollo 9. Colonel Scott will return to space with Apollo 15. He and astronaut James B. Irwin—not an alumnus—are scheduled to land less than a mile east of the moon's Hadley canyon.

These astronauts, along with Charles M. Duke, S.M.'64, and Dr. Philip K. Chapman, S.M.'64, Sc.D.'67, earned their degrees in the Department of Aeronautics and Astronautics. Dr. Chapman was among 11 scientist-astronauts selected in 1967.

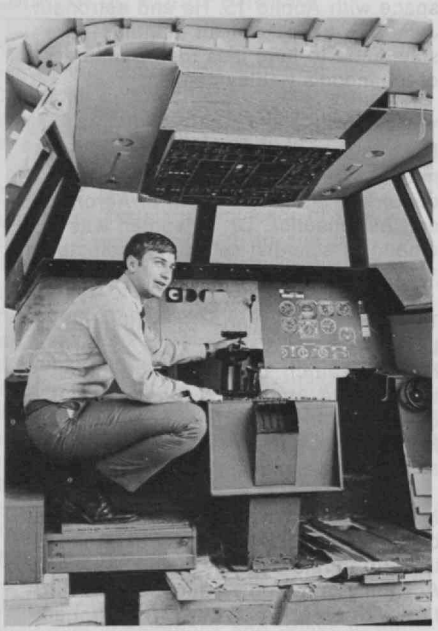
Two other M.I.T. men—Dr. William B. Lenoir, S.B.'62, S.M.'62, Ph.D.'65, of the M.I.T Research Laboratory of Electronics, and Anthony W. England, S.B.'65, S.M.'65, of the Department of Earth and Planetary Sciences—also are among the scientist-astronauts.

M.I.T.'s eight alumni among the astronaut corps hold a total of 14 graduate and undergraduate degrees. The U.S. Naval Academy is the only educational institution with an edge on M.I.T. in astronaut production with nine astronaut graduates.



Commander Edgar Mitchell, Sc.D.'64, took this picture of Alan Shepard as he assembled the core tube, part of their equipment for sampling the lunar surface. Beside astronaut Shepard is the Apollo 14 "golf cart."

Thomas Imrich, a graduate student in M.I.T.'s Department of Aeronautics and Astronautics, is busy reassembling the surplus "cockpit simulator" which he persuaded the Boeing Co. to give M.I.T. last winter. It will be used for air traffic control research. (Photo: Tech Talk*)*



In the Air on the Ground

Students and faculty in the Department of Aeronautics and Astronautics soon will have a research facility that will enable them to zoom aloft, face difficult problems in piloting aircraft, and come in for a perfect landing—all while resting on the ground.

The Department recently acquired a new and unique research facility. Thanks largely to the efforts of Thomas Imrich, an interprising aeronautics and astronautics graduate student, the Boeing Corp. has donated a "cockpit simulator" to M.I.T. Boeing flew the simulator, which is 18 ft. long, 9 ft. in diameter and weighs 4,000 lbs., from its plant in Seattle, Wash., to the Draper Laboratory's Flight Facility at Hanscom Air Force Base in Bedford. There it was cut in half so it could be trucked to M.I.T.

The Manned Vehicle and Flight Transportation Laboratories of the Department of Aeronautics and Astronautics and the Electronic Systems Laboratory of the Department of Electrical Engineering are working with Lincoln Laboratory personnel to rebuild the cockpit for research in air traffic control. However, since it has general-purpose flight simulation capabilities, the cockpit may be used for other types of experiments in the future.

The M.I.T. Student: Changing Direction, Not Turning Inward

Like snow on a windless night, quiet settled over the M.I.T. campus last June—and (with only a few sporadic interruptions) has remained. Why the absence of demonstrations after one tumultuous year? Where are the radical students, the alienated youth, and the antiwar movement? Does the quiet indicate a return to business as usual, or some deeper phenomenon—a psychic disaffiliation from commitment in any form? What is the mood on campus today, and will it remain calm?

Confessing a certain befuddlement over the rapidity with which the surface aspect of campus life has changed, and noting that it is "a time of confusion," J. Daniel Nyhart, Dean for Student Affairs at M.I.T., nevertheless attempted to answer such questions for members of the Alumni Advisory Council on January 18.

"The media, which are generally quick to perceive trends," he said, "describe a turning inward . . . a return to romanticism. . . . But I don't think the picture is that simple." Disillusionment, frustrated idealism, and disaffection are still there, the Dean believes. The introspective quiet may indicate a deepening of disillusionment, one extending even to protest—the first of five topics—protest, student governance, drugs, professional and life aspirations, and education—which he discussed in detail.

◇ *On protest:* This year has so far seen "an absence of the wide, mass political protest that marked last year. . . . I don't feel it part of my job to walk around with a bullhorn all the time."

Rosa Luxemburg S.D.S., the most visible radical group last year, has all but vanished from the scene. Many of its members graduated, withdrew, or were expelled at the end of last spring. Some have joined other radical groups off campus, forming collectives and cooperatives and attempting to organize working class and street people.

But many students who called themselves "revolutionaries" last spring, and many more just as radical but less inclined to violent tactics, are simply demoralized. Dean Nyhart quoted a student as asking him, "Where does an unsuccessful revolutionary go?" "Failure in that business," Dean Nyhart said, "is just as much a problem as failure in any other line of endeavor.

"I think they sense that really revolutionary tactics didn't work. But as a friend put it to me, 'First they discovered that working within the system didn't work; now they're finding out that apathy doesn't work either!' " And Dean Nyhart doesn't think the apathy will last. "Given an issue, given the appropriate time, given the springtime, I would not be sure that their voices will not be heard again."

◇ *On governance:* Dean Nyhart described how M.I.T. student government had its own revolution two years ago. A new constitution replaced what many students felt to be an inbred and bureaucratic Institute Committee with a participatory democracy, a 70-member undergraduate General Assembly. But in the meantime there has been a marked increase in student membership on faculty committees, commissions, and task forces. According to Dean Nyhart, students have found such positions to be real entries to student power—and this has actually weakened the General Assembly, drawing away its potential workers.

◇ *On drugs:* The Dean's office had this year feared an increase in the use of marijuana as well as increased use of "harder" drugs such as LSD and amphetamines, following patterns established in previous years. Also, based on its rising incidence among high school seniors, cases of heroin use were anticipated.

It didn't happen. According to reports, use of marijuana has actually decreased recently as has taking of the harder drugs, and the narcotics influx has not occurred.

Dean Nyhart said he could offer no ready explanation, but he did have a couple of hypotheses. One is that students in the drug scene heavily just aren't going to college—certainly not to M.I.T.

◇ *On education:* Where last spring the activist spent much of his time rallying, organizing, leafletting, etc., he is now going back to his studies. Dean Nyhart takes this not as a sign that M.I.T. students are giving up efforts oriented toward social improvements; on the contrary, he thinks this indicates a determination to settle in for the long haul—a return, in part, to working within the system and gaining the clout that an M.I.T. degree can carry. Dean Nyhart emphasized that students are very concerned with integrating human values into their education. But paradoxically there has been a decreased enrollment this fall in those courses concerned with social change.

On the other hand, interest in such things as the new interdisciplinary Environmental Projects Laboratory indicates a return to a more traditionally "M.I.T." approach to problem solving—through technology.

Another educational trend is the marked increase in the number of sophomores who do not decide on their M.I.T. major departments at the end of the freshman year, apparently out of a desire to explore more alternatives before making the decision. The withdrawal rate is also up. Dean Nyhart perceives both as healthy trends; in fact, it has been the policy of

N. Cohn, '27

K. E. McVicar, '50

P. B. Repetto, '58

R. E. Siegfried, '47

R. D. Holmes, '61

D. P. Herron, '41

the Dean's office to encourage students to take time off to ease the pressure, and a student who withdraws voluntarily often manages to return and earn his degree.

◊ *On aspirations:* But it was in discussing students' hopes and plans that Dean Nyhart may have hit upon the real nature of the great calm and the real mood of the M.I.T. student today, who—perhaps more than any other student in the nation—is aware of the forces at work shaping the future. Dean Nyhart quoted one such student who had accompanied him the previous Saturday to a meeting of the M.I.T. Club of Delaware Valley. The student told the alumni: "The determinants of my happiness are going to be how satisfied I am with myself, with my relationships with other human beings, with the way I am contributing to society. And they are not going to be dependent upon and encompassed by the occupation in which I am engaged."

An alumnus asked him, "Where do you want to be thirty years from now?"

He replied, "Alive."

And added, "I think there is going to be trouble. I think we are going to have trouble surviving."

Individuals Noteworthy

Joseph B. Taylor, S.M.'56, to President, Maine Water Utilities Association . . . **Robert F. Seedlock,** S.M.'40, to Chief Engineer—capital improvements, Pittsburgh Port Authority . . . **John W. Barriger,** '21, to President, Boston and Maine Railroad . . . **Howard S. Turner,** Ph.D.'36, President, to Chairman of the Board, Turner Construction Co. . . . **David V. Ragone,** '51, Dean of the Thayer School of Engineering, to Board of Trustees, MITRE Corp. . . . **Nathan Cohn,** '27, to Chairman of the Board, Franklin Institute . . . **Kenneth E. McVicar,** S.M.'50, to Assistant Vice President and **Werner E. Sievers,** '52, to Associate Technical Director—Surveillance and Defense Systems Division, MITRE Corp. . . . **George W. Armerding,** S.M.'60, to Vice President, Capital Data Systems, Inc. . . . **Gerald S. Rosenfelder,** S.M.'67, to Executive Director—Engineering, Bell Aerospace Division of Textron, Inc. . . . **James C. Nagel,** '48, to Staff Industrial Engineer, Converse Rubber Co.

Robert G. Dettmer, '55, to President, George J. Meyer Manufacturing Division, A-T-O Inc. . . . **Russell N. Cox,** '49, to President, General Investment and Development Co. . . . **Paul B. Repetto,** '58, to Vice President—administration, Chicago office of Foote, Cone and Belding . . . **Paul N. Schregel,** S.M.'64, to Manager—market information and planning, Scott Paper Co. . . . **Robert E. Siegfried,** S.M.'47, President, to Chief Executive Officer, the Badger Co., Inc. . . . **Bert R. Chenault,** '49, to Managing Director, Badger Limited, London . . . **James G. Tewksbury,** Ph.D.'53, to Associate Director—energy group, National Institutional Department, Butcher and Sherrerd . . . **Richard D. Holmes,** S.M.'61, to Director—engineering, American Instrument Company, Baxter Laboratories, Inc. . . . **Reed H. Winslow,** '54, to Department Head—Transportation Systems Planning, MITRE Corp. . . . **David P. Herron,** '41, to President, Industrial Systems Division, Aerojet-General Corp.

Paul A. Kossler, '58, to Senior Engineer/Manager, Advanced Systems Engineering, I.B.M.'s Electronics Systems Center . . . **Jerry R. Collen,** '57, to Vice President and General Manager, Visual Security Systems, Inc., division of I.T.I. Electronics, Inc. . . . **Michael P. Greenberg,** '58, to Chief Engineer, MODICON Corp.

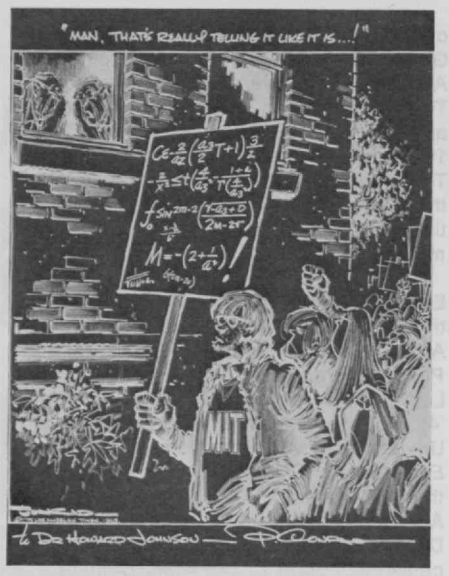
Jerome W. Lindsey, Jr., M.C.P.'61, to Associate Dean of the Faculty of Design, Harvard University . . . **Joseph E. Stiglitz,** Ph.D.'66, to Full Professor, Economics, Yale University.

M.I.T. appointments: **Julian Beinart,** M.A.R.'56, to Visiting Professor, Department of Architecture . . . **Elias P. Gyftopoulos,** Sc.D.'58, to Ford Professor of Engineering, Department of Nuclear Engineering . . . **Gordon H. Pettengill,** '48, to Professor, Department of Earth and Planetary Sciences.

To **Norman A. Phillips,** Head of the Department of Meteorology, M.I.T., the Carl-Gustaf Rossby Research Medal of the American Meteorological Society . . . To **Victor F. Weisskopf,** Chairman of the Physics Department, M.I.T., the George Gamow Memorial Lectureship Award of the University of Colorado . . . To **John C. Slater,** Institute Professor and Professor of Physics, Emeritus, the 1970 National Medal of Science . . . To **Norman Levinson,** '33, Chairman of the Mathematics Department, M.I.T., the 1971 Chauvenet Prize of the Mathematical Association of America.

Edgar D. Mitchell, Sc.D.'64, one of the three astronauts aboard the flight of Apollo 14 . . . **Albert C. Zettlemoyer,** Ph.D.'41, Provost and Vice President, Lehigh University, and **Joseph F. Libsch,** '40, Vice President for Research, Lehigh University, listed in the first edition of *Engineers of Distinction,* published by the Engineers Joint Council . . . **Les Aspin,** Ph.D.'66, to U.S. Congress as Democratic Representative from Wisconsin . . . **John C. Sheehan,** Camille Dreyfus Professor of Chemistry, M.I.T., to 12-member National Advisory Research Resources Council of the National Institutes of Health . . . **Albert J. Kelley,** '48, Dean of the School of Management, Boston College, to Chairman of the Board of Economic Advisors to the State of Massachusetts . . . **Reuven Leopold,** '61, to Technical Director of the Ship Concept Design Division of the U.S. Naval Ship Engineering Center . . . **David R. Israel,** to Director, Office of Systems Engineering Management, Federal Aviation Administration.

To **Charles Stark Draper,** '26, President, Draper Laboratory Division of M.I.T., Honorary Membership in the British Institute of Navigation of the Royal Geographical Society; and to **David G. Hoag,** '46, Deputy Director of the Draper Laboratory, a Special Award from the British Institute of Navigation; both in recognition of their work in the development of the guidance and navigation systems for the Apollo spacecraft . . . **W. H. Krome George,** '40, to membership on the newly created Commission on American Shipbuilding . . . **Robert M. White,** Sc.D.'49, to Administrator, National Oceanic and Atmospheric Administration . . . **Crawford H. Greenewalt,** '22, to Chairman—organizing committee, Twenty-Third International Congress of Pure and Applied Chemistry.



M.I.T. student Becky Donnellan "standing up" for the Institute (above). She is talking with the father of a Florida high school student at a meeting of the M.I.T. Club of Central Florida.

A present for Howard Johnson (left)—the original artwork for this cartoon by Paul Conrad, editorial cartoonist of the Los Angeles Times*—presented at a meeting of the M.I.T. Club of Los Angeles.*

John R. Wittels, '47, (above left) President of the M.I.T. Club of Los Angeles presenting the original drawing of the Conrad cartoon to President Howard Johnson.

Alumni Seminars: Health Care, Power and "Conversion"

Two seminars for M.I.T. alumni on broad issues confronting technology in the U.S. have been announced for April and May, 1971:

◇ Engineering Opportunities in the Health Care Industries—a review of present and future contributions of engineers and scientists to more effective health care and its delivery—at M.I.T. on April 24 and 25.

◇ Providing Energy for the Future—lectures, workshops, and panel discussions on energy production and its environmental implications—at M.I.T. on May 1 and 2.

In addition, the M.I.T. Alumni Association will sponsor a career seminar, intended for alumni who are considering a change in career orientation as a response to changing national priorities, at the Institute on April 17 and 18.

All three seminars are open primarily to M.I.T. alumni, and reservations may now be made with the Alumni Association, Room E19-439, M.I.T., Cambridge, Mass. 02139. Registration fees (including enrollment, reading materials, and meals—but not housing) are $35 per person for alumni and their families and $80 per person for those with no immediate M.I.T. affiliation.

No special background is required for any of the seminars. All will include lectures, discussions, and workshops during four periods on Saturday and Sunday and an evening session following dinner on Saturday.

The career seminar will include sessions on future needs for engineering, scientific, and management talent; employment opportunities; personal adjustment problems of those who attempt to change careers; and such practical topics as resumes, placement services, and career-development resources.

Topics to be covered in the health care industry seminar (April 24 and 25) include "the medical mystique," the present structure of the medical industry, current and future markets for present medical technology, and new areas where technology will be needed.

The final seminar will open with a review of the supply and demand for power—past, present, and future; speakers will then explore the effects of different future courses of action on the world heat and energy balance, pollution levels, and the quality of life.

M.I.T. Club News

At a dinner meeting of the Los Angeles Club this winter, Paul Conrad, editorial cartoonist of the *Los Angeles Times,* had arranged a surprise for Howard Johnson, M.I.T.'s retiring president. Mr. Conrad relinquished the original of the M.I.T. cartoon (*shown above*) which was presented to President Johnson by John R. Wittels, '47, Los Angeles Club president.

The Miami Valley M.I.T. Club sponsored a student-alumni discussion on changes at M.I.T. and the work of the M.I.T. Commission, "Creative Renewal at a Time of Crisis," this January. Alumni of courses and fields of interest from business to metallurgy, from the bachelor's to the Ph.D., and representing classes from '27 to '61 discussed the present-day campus with M.I.T. student Roger Stucke. The club elected a new president at this meeting—Will B. Rodemann, '44: "Railroaded" Mr. Rodemann says.

When the M.I.T. basketball team went south this winter for the Suncoast Classic Basketball Tournament, the M.I.T. Club of Central Florida took the opportunity to brunch with the players. There was no formal program—just an alumni-student opportunity to meet and become acquainted. Alumni, wives, M.I.T. students, high school students interested in attending M.I.T., and parents were invited.

Alumni Calendar

Boston—April 8, Thursday, 12:15 p.m.—Luncheon meeting, Aquarium Restaurant, 100 Atlantic Ave. Speaker: Robert W. Simpson, Ph.D.'64, Associate Professor of Aeronautics and Astronautics, M.I.T. Topic: Boston and Air Travel.

—May 13, Thursday, 12:15 p.m.—Luncheon meeting, Aquarium Restaurant.

Chicago—April 16, Tour of Bell Telephone Laboratories, Inc., Naperville, Ill.

—May 13, Thursday, 6:30 p.m.—Dinner meeting, honoring James R. Killian, Jr., '26. Jacques Restaurant.

Cleveland—April 20, Tuesday, 6 p.m.—Dinner meeting, Somerset Inn. Speaker: Paul V. Keyser, President of the Alumni Association.

New York—April 19, Monday, 8:30 p.m.—M.I.T. Symphony Orchestra, David Epstein conducting at Carnegie Hall—Presentation of the Silver Stein to James R. Killian, Jr., '26, by Julius A. Stratton, '23, President Emeritus M.I.T.—Preconcert reception and buffet supper honoring Dr. and Mrs. Killian at 6 p.m. in the Grand Ballroom of the Park-Sheraton Hotel.

—May 11, Tuesday, 8:30 p.m.—Chamber music at Carnegie Recital Hall. M.I.T. faculty and students as composers and performers. Informal reception for the musicians in Cafe Carnegie immediately following the concert.

Philadelphia—May 5, Wednesday, 6:30 p.m.—Dinner meeting honoring James R. Killian, Jr., '26, the Union League.

Portland, Me.—May 6, Thursday, 6 p.m.—Dinner meeting. Speaker: A. Scheffer Lang, '49, Professor of Civil Engineering, M.I.T. Topic: Analysis of Transportation Systems.

San Francisco—April 23, Friday, 6:30 p.m.—Cocktail reception at the St. Francis Yacht Club honoring Dr. and Mrs. James R. Killian, Jr. ('26). Presentation by Thomas K. Sherwood, Sc.D.'29, Professor of Chemical Engineering, Emeritus, M.I.T.

Cambridge—June 4-6, Friday-Sunday—Class Reunions at M.I.T. and other locations.

—June 6, Sunday, 9:30 a.m.-5 p.m.—M.I.T. Student Center, Conference for Club Presidents.

—June 6, Sunday—M.I.T. Night at the Pops

—June 7, Monday—Homecoming Day.

Deceased

Emma E. Ferris, '01, June 30, 1967
Edward J. Poor, '05, February 7, 1971*
Leonard W. Pritchett, '09, November 15, 1970*
Harold A. Smith, '10, December 28, 1970*
Harold E. Babbitt, '11, October 10, 1970
Frederick O. Stillman, '13, February 1, 1971
Kenneth W. Roy, '15, January 3, 1971
Irving McDaniel, '16, February 22, 1971*
Duncan S. Owler, '16, December 18,
Erling B. Stockman, '17, December 6, 1970*
Joseph Herzstein, '18, January 31, 1971*
Louis A. McCarthy, '19, n.d.
William F. Saunders, Jr., '19, November 4, 1969
Frank D. Gage, '22, June 1971*
Domnall F. Kelly, '22, November 26, 1970
Harris B. McIntyre, '22, January 30, 1971*
George H. Ludlow, '23, January 19, 1971
Henry R. Kane, '24, February 12, 1971*
James C. L. Wong, '24, April 27, 1970*
Vicente Elorza, '26, May 28, 1969
Leslie Currier, '26, January 3, 1970
Ray Holgate, '26, December 25, 1970*
James R. Buckley, '27, December 20, 1970
Joseph L. Burke, '27, July 23, 1970
Charles L. Hibbard, Jr., '28, February 20, 1971
Robert J. Joyce, '28, January 22, 1971*
Perry S. Lobdell, '32, December 5, 1970
Leonard I. Schiff, '37, January 19, 1971
Harrison M. Lavender, '42, November 6, 1970
Lloyd G. Elliott, '43, November 29, 1970
Ross H. Compton, '45, January 17, 1971
Robert B. Hildebrand, '45, January 31, 1971
John D. Eichenberg, '49, December 9, 1970
George W. Beardsley, '59, January 16, 1971*
Romould Litwin, '59, n.d.
*Further information in Class Review

Talent Available

Technology Review and the Alumni Placement Office are joining to publish these announcements—without cost—for alumni seeking new professional opportunities. Graduates of the Institute who are registered with the Alumni Placement Office are invited to submit statements, not exceeding 50 words and including relevant details of field and date of degree, professional experience, and interests to the Editor, *Technology Review,* Room E19-430, M.I.T., Cambridge, Mass., 02139. Each announcement will be published in a single issue of the *Review;* subject to the availability of space, announcements received by the 25th of each month will appear in the *Review* published five weeks later. The identity of advertisers will not be revealed either in print or in correspondence; respondents' letters, addressed to the appropriate key number at *Technology Review,* will be forwarded unopened to the advertiser.

Sales manager—plastics and resins: Sixteen years technical sales background, including heavy experience in polyesters and urethanes. Prior assignments include product management, management of technical sales support, production management, and successful completion of major engineering assignments. Currently developing and implementing sales plans for major basic manufacturers' complete range of plastics products in 13 categories to overseas customers. S.B. mechanical engineering. Age 47, married. Location open. Key APA1.

Management specialist: Overall business management; marketing; or engineering. M.B.A. and S.M. (electrical engineering); 24 years experience in all management functions—communications, education and training, computers. Background in blue-ribbon companies as well as independent consulting. Interested in full time position or in consulting assignments. Key APA2.

Low temperature, solid state: Imaginative, curious, and resourceful, Ph.D. (physics) graduate of M.I.T. and Berkeley, ten years' research experience in microwave and lower frequency ultrasonics, surface waves, magnetic interactions and thermal conductivity. Seeks position in applied research with company in New York City metropolitan area. Key APA3.

Military, aerospace: S.M., age 65; 30 years' military service and 10 years aerospace at Cape Kennedy desires interesting work instead of retirement. Available September; salary not important. Key APA4.

Architect, space analyst, commercial interior designer: B.Arch., registered architect in Rhode Island and Massachusetts; own practice 15 years doing banks, supermarkets, offices, restaurants, clubs, automated post office, airport. Two years project manager for large New York firm on major building projects. Willing to travel and relocate. Key APA5.

Mexico, Central and South America: General manager, marketing director. Experienced all phases chemical, allied industries, sales, marketing, accounting, production. Citizen Mexico, S.B. in chemical engineering, M.B.A. At present in Mexico—N.Y. interviews in April, 1971—West Coast dates can be arranged. Key APA6.

Mechanical engineer: S.B. 1935, graduate studies in servomechanisms, hydromechanics, kinetic theory, business administration, and education. Skilled in design and development of satellite and space probes, solid propellant rockets, ordnance, microwave antennas and plumbing, servosystems, and mechanical power drives. Experienced in organization and administration of personnel, budgets, and proposals. Key APA7.

System engineering—guidance and control—servo/instrumentation—medical instrumentation: S.B. in electrical engineering, S.M. and Sc.D. in aeronautical engineering; 27 years in teaching and research and development in instrumentation, air traffic control, missile guidance. Latest pursuits: sphygmomano-register proposal submitted to N.I.H., strapped-down I.R.U. and advanced missile guidance with triple tracking sensor configuration. Key APA8.

Management consultant: unusual ability to improve business operations, profits, management and managers—and evaluate investments. Can extend capabilities of a good executive or entrepreneur. Value proven. Seek: #2 job in $100-million or larger company, top financial or planning position, or investment firm association; $40,000 range. Key APA9.

Nuclear particle physicist: seeking new field, perhaps engineering process design or development. Chemical engineering background with eight years' teaching and research experience at the University of California; much computer calculation and data processing. S.B., S.M. (minor in nuclear engineering) from M.I.T., 1952 and 1954; Ph.D. in physics from University of California (Berkeley), 1963. Key APA10.

Mathematician: S.B. M.I.T. '64, Ph.D. Arizona '69 in pure mathematics, now teaching undergraduates (number theory, linear algebra, logic, etc.). One publication, in geometry of numbers; 27, single. Interested in teaching, industrial, or other position in mathematics, available June. No geographic preferences. Key APA11.

Civil engineer structures and soils: Sc.D. '64. Varied experience in dynamics applied to structures, piping (acoustical), and foundations. Recent extensive work in auto/high-way safety involving crash testing of experimental safety vehicles; biomechanical studies for safety standards. Desire teaching/research in general or safety areas. Key APA12.

Business development executive: Over 20 years proven success selling multi-million-dollar projects for leading international engineer-contractors. S.M. in chemical engineering, M.B.A. Interested in new business development for engineer-contractor or corporate development for a petroleum or chemical company expanding by acquiring or constructing new facilities. Experienced project evaluation, financing, technology transfer, joint ventures, negotiation agreements. Key APA13.

Ship construction/conversion: experienced in planning, budgeting, design review, contract administration, and performance evaluation. Desire responsible position in transportation industry or education. S.B. from Naval Academy, S.M. from M.I.T. in naval architecture and marine engineering. Key APA14.

Utility or process engineering: S.B. in electrical engineering 1956, with strong planning, business, computer and public service background, seeks return to power utility field or process plants in engineering or managerial position. Age 36, married, two children, able to relocate. Key APA15.

Science administration: Ph.D. in physics, M.I.T., presently employed, seeking more congenial environment in science administration or management in academic, industrial, or government organization. Present experience in management consulting; recent experience in management of industrial research and development laboratory specializing in water, air pollution, heating, plumbing, air conditioning equipment, controls, and materials development. Key APA16.

Civil engineering: S.M. with 21 years' experience in management, water resources, planning, operations, and maintenance. Also experienced in scuba diving, teaching, public relations, writing and operations research. Particularly interested in oceanography and limnology. Prefer Southwest or West. Key APA17.

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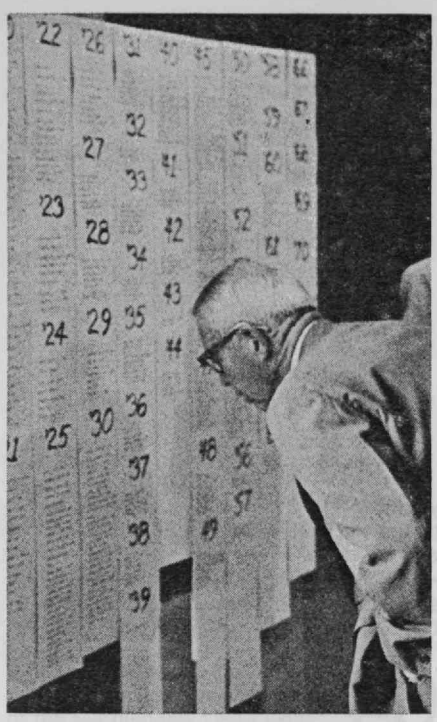


1971 Reunions: Shore Dinner, Luau, Athletics

Five reunions—the largest group in history—will be held on the M.I.T. campus on June 4 to 6 this year, and six other M.I.T. classes will gather on the same dates at favorite New England resorts.

The on-campus reunions will join for two unusual features—a session on "Inside M.I.T." being developed by Kenneth R. Wadleigh, '43, for Saturday morning, and a special performance of "The Proposition," Boston's longest-running theatrical production, in Kresge Auditorium on Saturday evening.

President Howard W. Johnson will participate in five reunions over the three-day period. He and Mrs. Johnson will be hosts to the traditional reception for the 25-year Class of 1946 on Saturday noon; they will attend the Class of 1951 Banquet at the Provincetown Inn that evening; and they will receive the Classes of 1921 and 1931 at the President's House on Sunday afternoon.

Other reunion program highlights as known when this issue of *Technology Review* was going to press:

◇ The Class of 1912: a shore dinner at Hugos' Lighthouse, Cohasset, Mass., on Sunday noon, June 6.

◇ A Polynesian luau at the Jug End Barn in the Berkshires for the Class of 1936 on Saturday noon.

◇ Special island activities—athletic events and bicycle tours—for the Class of 1956 from the Harbor View Hotel at Edgartown, Mass. (on Martha's Vineyard Island); 86 members of the Class are already registered—a record for any 15-year class.

Those who need reunion information are urged to use the coupon.

Reunions 1971

60th	'11	Oberlin S. Clark 50 Leonard Road North Weymouth, MA 02191	M.I.T. Campus
55th	'16	Ralph A. Fletcher Box 71 West Chelmsford, MA 01863	Chatham Bars Inn Chatham, Mass.
50th	'21	George Chutter Boulder Drive Box 305 East Dennis, MA 02641	M.I.T. Campus
45th	'26	Donald S. Cunningham 35 Talbot Street Braintree, MA 02184	Chatham Bars Inn Chatham, Mass.
40th	'31	Ralph H. Davis 66 North Street Lexington, MA 02173	Bald Peak Colony Club Melvin Village, N.H.
35th	'36	Henry G. McGrath 409 Wayne Terrace Union, N.J. 07083	Jug End (Berkshires) South Egremont, Mass.
30th	'41	Edward R. Marden Edward R. Marden Corp. 280 Lincoln St. Allston, MA 02143	M.I.T. Campus
25th	'46	Edwin Tebbetts N.E. Mutual Ins. Co. Actuarial Dept. 501 Boylston Street Boston, MA 02117	M.I.T. Campus
20th	'51	Jay Rosenfield 3 Bartlett Street Marblehead, MA 01945	Provincetown Inn Provincetown, Mass.
15th	'56	William S. Grinker 21 Woodward Road Framingham, MA	Harbor View Hotel Edgartown, Mass.
10th	'61	Dr. Jerome H. Grossman Massachusetts General Hospital Lab of Computer Sciences Boston, MA 02114	M.I.T. Campus
5th	'66	William H. Byrn, Jr. 995 Massachusetts Ave. Arlington, MA 02174	M.I.T. Campus

Use this Coupon for Reunion Information

Panos D. Spiliakos, Alumni Association, E19-438, M.I.T., Cambridge, Mass. 02139

Tell the Reunion Chairman for my Class that I need information and reservations forms for the 1971 reunion.

(Name) (Class)

(Address)

(Zip Code)

Class Review

95

Now that **Luther Conant** has departed, I have no classmate. Congratulations to Miss Brenda Kelley on her appointment to Associate Editor.

Easter Greetings.—**Andrew D. Fuller,** Secretary, 1284 Beacon St., Brookline, Mass. 02146

96

Three grandsons of members of the class who also are named for their '96 grandfathers are now in college. William Barbour 3rd attended a college in upstate New York for a year but, as a drama major, found it to be too far away from Broadway and transferred to co-educational Sarah Lawrence. William D. Coolidge 2nd is enrolled in the University of Colorado at Boulder and James M. Driscoll 2nd is a freshman in engineering at Villanova University. Perhaps some demographer can draw some conclusion from these data!

Post holiday messages from the senior **William Barbour** and **William Coolidge** indicate that they both are in good health and excellent spirits.— **Clare Driscoll,** Acting Secretary, 800 4th St. S.W. #S304, Washington, D.C. 20024

98

April is a historic month in the annals of M.I.T. In April 1861 William Barton Rogers received the Act creating the Massachusetts Institute of Technology. You may remember the celebration ten years ago in April 1961 of the Centennial of this historic occasion. The committee in charge mailed out an attractive brochure of the program, bound in thick cardboard, displaying on the front cover three medallions: at the top enclosing the M.I.T. "Mens et Manus" seal; in the middle a black and white sketch of the globe (over which the graduates of M.I.T. have spread); at the bottom, a large capital C indicating one hundred years.

Turning inside was a pen and ink sketch of the front of Old Rogers on Boylston Street, showing the famous "Roger's Steps" where ninety-eighters frequently gathered in student days. We quote from the next page, "Just one hundred years ago, on January 11, 1861, thirty-seven leading Boston citizens met in Mercantile Hall on Summer Street to support William Barton Rogers' plans for a new kind of educational institution in Boston. Before leaving that night they signed an agreement which Dr. Rogers later endorsed as the 'Original Act of Association of the Institute of Technology.' Barely three months later, on April 10, 1861, Governor John A. Andrews approved the Act of the General Court of the Commonwealth creating the Massachusetts Institute of Technology." —Mrs. **Audrey Jones Jones,** Acting Secretary, 232 Fountain Street, Springfield, Mass. 01108

02

A letter from **Albert Lombard,** Pasadena, Calif., would indicate that all is well with him. His son, Dr. Albert E. Lombard, Jr. is a vice president of McDonnell Aircraft Corporation in St. Louis where he is in charge of the department of research. His daughter, Margaret Lombard Heimer, is married to Dr. Harry J. Heimer, who graduated from M.I.T. and received his Ph.D. at Cal Tech. They are living in Newport Beach, Calif. Margaret usually comes to see him each Tuesday. Albert says he has been feeling the earth quake but all is well with him.

Come June, I will have completed my thirty-fourth year as Class Secretary. Last October at a meeting of the M.I.T. Alumni Association and the Editors of the *Technology Review,* I was one of the group of class secretaries who had served 25 years or more and in recognition, received a silver replica of the *Review*'s logo and a certificate of appreciation.—**Burton G. Philbrick,** Secretary, Greycroft Inn, 68 Dane St., Beverly, Mass. 01915

03

Well, classmates, another note of warning for a blank 1903 news column. Next month will be the same if you fail to help your Secretary on even a postal note, telling me that you are fortunately alert and still loyal to our classmates' interest. —**John J. A. Nolan,** Secretary-Treasurer, 13 Linden Ave., Somerville, Mass. 02143

04

The only news we received this month were the following changes of address: **Albert C. Blaisdell,** c/o Mountain View Towers, 3120 Acacia Dr., Cheyenne, Wy. 82001; and **Fred M. Pierce,** 443 Seventh Ave. No., St. Petersburg, Fla. 33701.

Please send your Secretary more news of your activities.—**Eugene H. Russell,** Secretary, 82 Stevens Rd., Needham, Mass. 02192

05

Little news is bad news this month. I have to report the death of **Edward J. Poor.** Since we have had little to report on Ed for many years I am quoting in full from the *Boston Herald* of February 8, 1971.

"Edward J. Poor, 88, retired board chairman of G.T.E. Sylvania Inc., died yesterday at Broward General Hospital in Fort Lauderdale, Fla., his winter home.

"Poor, a native of Peabody, pioneered Sylvania's entry into both the electronic tube and fluorescent lighting fields. He was the second of three brothers whose name was associated with Sylvania for half a century. Frank A. Poor, who died in 1956, founded the company in 1901, and Walter A. Poor was chairman of the board at his death in 1950.

"Edward Poor studied electrical engineering at M.I.T. and joined Sylvania in 1904. He expanded sales outlets and introduced the direct mail technique to the light bulb industry. During the 1920s, he developed a plan with the Philco Corp. for shipping radios with tubes already in place. His plan was based on production of more rugged tubes and affected industry-wide radio merchandising. Poor also served as Sylvania

"My favorite outdoor sport," says Dean Klahr, '05.

board chairman from 1931-46 and as a company director until he was 62. He also had served as president of Bay State Lamp Co. and Hy-grade Incandescent Lamp Co., both predecessors of Sylvania.

"A widely known East Coast yachtsman and an ardent golfer, he was a member of the Marblehead Yacht Club and was responsible for the building of the Salem Country Club in 1926. He spent his summers in New London, N.H. He leaves his wife, Grayce; four children by a previous marriage: a daughter, Mrs. Marie L. Drake of New London, N.H.; three sons, David E. of Swampscott, Leonard F. of Boston and Raymond J. of Wenham; and eight grandchildren."

Ed and I grew up together in Peabody, Mass. I remember visiting him occasionally in his office in a small building in Salem where Sylvania really started. There were a lot of Poor boys (I was one —pardon the pun) who went to M.I.T. from that immediate section: Arthur W. '08, Fred W. '06, Nathan H. '13 and Walter E. '08.

The accompanying picture shows us how **Dean Klahr,** 90 years old last October, gets his exercise and maintains his vigor. Anyone wishing to top Dean in this department please send entries (and pictures) at once.—**Fred W. Goldthwait,** Secretary, Box 32, Center Sandwich, N.H. 03227

08

We have news from **John S. Barnes,** M.E., of White Plains, N.Y. He started work with Merrel Soule Co. of Syracuse N.Y., who had been in the food business since 1857. Irving Merrel, his boss, graduated from M.I.T. in 1896. They were just developing powdered milk. While with Merrel Soule they built 14 small plants in eastern U.S. and Canada for spray drying of foods. In 1930 they sold out the business to the Borden Co. and he moved to their main office in New York living in White Plains. While with Borden he was chief engineer of their Food Production Division, covering some 70 plants throughout the U.S. and Canada, manufacturing a great variety of food products, pioneering in the perfection of powdered coffee. He retired in 1957 and lived in White Plains until his wife died in 1968 and then moved to live with his daughter at Gurneseytown Rd., Watertown, Conn. He has two sons both retired and he is in excellent health at 85.

We also received a nice letter from **Louis S. Gordon** of Miami Beach, Fla. He writes that M.I.T. has meant so much to him in a greater and clearer understanding and enjoyment of life—for this he has always been most grateful. Following his degree in metallurgy, he did some work in coal and copper mining. After 45 years as underwriter of The Equitable Life Assurance Society in New York he decided to get into a warmer and cleaner atmosphere. Now at Miami Beach his great problem is to find something to do. He sends his best regards to all the surviving classmates.

Notice has been received from the Alumni Office of these changes of address: William R. Heilman, 211 S. Bond St., Berkeley, Calif. 47170; and John R. Reyburn, 117 Junius St., Thomasville, Ga. 31792.—**Joseph W. Wattles,** Secretary, 26 Bullard Rd., Weston, Mass.

09

We were pleased to receive the following communication from **Art Shaw** from his winter resort at Longboat Key, Fla.: "I am late in my winter report to you! This is our first real rainy day (February 8) since our arrival in the Sunny South last November 27, so there is no excuse for not catching up on letter writing. I have attended two meetings of the Technology Club of Southwest Florida—one stag and the other with wives. I saw there several ex-Bostonians whom I used to meet in the Boston area. Incidentally, my joining this Florida Club has caused some misunderstanding at the headquarters of the Alumni Association where I recently discovered my address had been changed to my Florida residence. I have taken steps to correct this. Auburndale is still my legal residence. A printed roster of members of the alumni living in southwest Florida recently issued contains two names of '09 men (besides mine). They are Lieutenant Colonel **G. E. Hodsdon** and **Thomas Spooner,** both living in Fort Myers. I have been hopeful of seeing them at some of the club meetings but I presume that for them, as I find it for me, the 75-mile trip is a bit long for merely social reasons. However, if I find myself within striking distance of Fort Myers, I shall try to call on them. Betty and I are enjoying ourselves among our Florida friends in our usual quiet way appropriate to 'elderly' behavior and are glad to be missing the rather rugged season that New England seems to be having. Our warm regards to you and to any others you may run across."

Already we have stated that **Florence Luscomb** continues to be very active and recently has been one of our best sources of news for these notes. On Monday, February 15, it was announced over the radio that a meeting of the Women's Liberation Movement was held in the Charles Street Meeting House, Boston, and led by Florence, it was demanded that February 15, Susan B. Anthony's birthday, be made a national holiday. An attempt to reach President Nixon by telephone was unsuccessful but a telegram was sent. As is generally known, Susan B. Anthony (1820-1906) of Massachusetts was an early and ardent leader for women's rights and women's suffrage.

The death of Henry B. Kane, '24, (known to most of us as "Chick"), on February 12 came as a shock to us all. As the first Director of the Alumni Fund, the office which he held for so many years, he was well known to nearly everyone in the class. We all remember the friendly personal letters which we received so promptly acknowledging with gratitude our gifts to the Alumni Fund no matter how modest. We have written to Mrs. Kane expressing the sympathy of the class as well as our own.

We have received notice of the death of **Leonard W. Pritchett,** 84, in Clinton, Conn., the services for whom were held on February 11. Son of Henry S. Pritchett, President of the Institute during our early years as students, he was born in New York and prepared for the Institute at Morristown School. He graduated from Harvard University in 1908 with an A.B., then entered M.I.T. Our records show

that in the early years after graduation he lived in El Paso, Texas and Denver, Colo. In 1939 he joined the Bankers Trust Company of New York where he became trust officer. We were well acquainted with Leonard for he was a member of Course VI and played on the class baseball team.—**Chester L. Dawes,** Secretary, Pierce Hall, Harvard University, Cambridge, Mass. 02138; **George E. Wallis,** Assistant Secretary, Wenham, Mass. 01984

10

I was informed of the passing of **Harold A. Smith** on December 28, 1970 by Jack Babcock. The following is from the *Miami Herald:* "Services for Harold A. Smith, 83, a retired engineer with the International Shoe Co. in St. Louis, will be at 11 a.m. today at the Lithgow 54th Street Chapel. Mr. Smith died Monday at North Shore Hospital. Mr. Smith came to Miami in 1952 from Manchester, N. H. and lived at 769 N.E. 72nd Ter. He graduated from Massachusetts Institute of Technology in 1910 and worked for the International Shoe Co. for 30 years. Mr. Smith was a charter member of the Manchester Country Club and was a 32nd degree Mason. He was a member of the Miami Shores Country Club, the Mahi Shrine, the M.I.T. Club of South Florida, Theta Chi Fraternity and the National Association of Watch and Clock Collectors Inc."

The following note was received from **Alva Court:** "Had one cataract removed on 1/6/71. Don't know whether I'll have the other one removed or not—depends on how much my vision improves after I get glasses adjusted. Maybe I've seen as much as I should already."

Your Secretary preceded Alva by a few days and I have found that my sight is improving to the extent that I am now able to read as well as ever. Here's hoping that Alva's vision will improve to equal that of your Secretary—**Herbert S. Cleverdon,** Secretary, 112 Shawmut Ave., Boston, Mass.

11

The time is getting short. About the time these notes reach you you will receive another letter from the Reunion Committee enclosing a registration form. As this is being written, 19 Eleveners have said they intend to be on hand in June. Let's make it twenty-five.

Late in February **Roy MacPherson** called on me thus supplementing a letter from him a few weeks earlier. He was down this way looking after the well-being of his boat which is pulled out for the winter near here. He isn't able to use the boat as much as he would like to but enjoys working on it and giving lessons in piloting and navigation. His wife, Ina, is badly crippled and gets around the house with the help of a walker. She busies herself with crossword puzzles and the television. Roy still visits the Veterans' hospital in West Roxbury where he helps the boys in many ways, particularly with their ham radio station. He has a station of his own at home and another in his boat. Before leaving my house he agreed to be at the reunion.

Harry Tisdale sent me some letters together with newspaper clippings, twenty to thirty years old, regarding General **George Kenney.** They indicate clearly what George was doing and thinking about in those days. Harry asked me to give them to George at the upcoming reunion as he thought the general would be interested; I know I was. Harry is now vice president of the local Chapter of the AARP, helping his neighbors in every way he can including acting as cashier at at auction for the Ft. Myers Beach Free Public Library which took in over $5000.

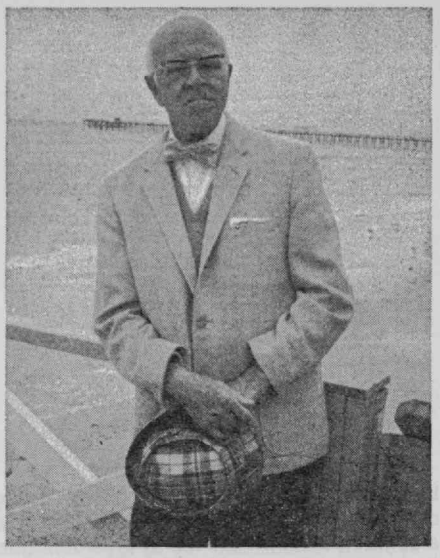
Ralph Runels extends his personal regards to all classmates. He is most disturbed about recent happenings at Tech, particularly the handling of the riots of a year ago and the hippy type dress of many students. His opinion of our great school has deteriorated somewhat. . . . **D. P. Gaillard** has moved to The Rocks, Pierce Mill Rd., N. W., Washington, D.C. 20010. . . . **Eldred Besse** is recovering from a post operative coronary.

Dean **Roy A. Seaton** of the School of Engineering, Kansas State College, Manhattan, Kan. 66502 died May 23 of last year. He was born in Glasco, Kansas, attended Kansas State Agricultural College, and graduated from M.I.T. with a master of science degree in mechanical engineering. He taught at Kansas State College for many years, but had been seriously ill for a number of years.

A number of cards returned from the February 1 Reunion Committee letter expressed the wish to be remembered to classmates while giving reasons, mostly health and distance why they will not be on hand. It seems to me it is worth a little extra effort to make it. It will be our last formal reunion.—**Oberlin S. Clark,** Secretary, 50 Leonard Rd., North Weymouth, Mass. 02191

12

This has been a delightful winter to be in Florida with the weather mostly sunny and warm. Presently, there are three 1912 men living nearby, **Paul Tyler** at Holmes Beach, **Jack Lenaerts** in Venice and **Jay Pratt** at Reddington Beach, St. Petersburg. **Harold Brackett** planned to arrive on Longboat Key last month. We attended a Tech Club dinner in Sarasota last month as the guest of Paul. About 100 were present including members and wives. The speaker had lived in Russia for 14 years, and presented a most interesting talk on the country, followed by an animated discussion in which many joined. . . . Helen and I visited Jay Pratt and Priscilla at their hotel on the beach and enjoyed an excellent seafood



Jay H. Pratt, '12, enjoying a winter vacation at Reddington Beach, Fla.

luncheon. Neither has been too well this year but are gradually feeling better. We also enjoyed a pleasant visit with John Lenaerts and Marion who moved last year to a new apartment in Venice.

Since reporting the death of our friend, **Bill Lynch,** last month, I have received additional information from Howard More of Los Angeles, a long time friend and associate of Bill's, which will be of interest to his many friends in 1912. Bill suffered a stroke about a year ago followed by several others before his passing on August 21. These were caused by circulatory deficiencies which gradually weakened his memory. Bill enjoyed a long and successful career with the South California District of Alcoa where he served as sales manager for many years. He later became West Coast manager of their Electrical Department until his retirement in 1956. His wife, Mary, died in 1966. Bill had two children, a son Alan, and a daughter, Diana Wells. Alan is an artist, teaching at Metropolitan Museum in New York City and also in special courses at the University of California. Diana has three young children and is employed as a social worker for the City of Oakland, Calif.

Randall Cremer has delayed in sending in a summary of his activities. He was most active during his days at Tech where he was in the Tech Show for two years and a member of the Mandolin Club, the Portfolio and Classday Committees and president of the Walker Club. On graduation, he accepted a position as assistant to Professor Walker, and then went to Chile for a few years on an engineering job. During this period he married Dorothy, a Wellesley graduate. He then returned to New York City, where he became associated as an engineer with Frederick Snare Corporation in that city. There he remained until his retirement as vice president in 1958. Since then the Cremers have travelled extensively, and a few years ago, while on a trip, they bought a winter home in Palma on the island of Mallorca in Spain. They

have one son, George, M.I.T. '39, who is located in San Diego, Calif., as chief of the Solar Division of International Harvester Company. Randy and Dorothy continue to maintain their New York residence, although he is presently visiting with his son in California.

We have a letter from **Jim Cook.** "I cannot begin to tell you how much I enjoy the travel stories you have published as delineated by my good friends Willis Salisbury, Larry Cummings and others who are still mobile. Good for them! Our class members are now mostly eighty years old or more and I am convinced that all of them are familiar with the problems of advanced age. I live alone in a small apartment and am a housewife, 4th class. My hearing is poor. My right eye gives me problems in vision due to a little spot in front of the pupil. My right leg is over an inch shorter than the left and neither understands the antics of the other. However, stable footing offers no problem, but ice is a real danger.

"Last summer I visited Nahant with a fisherman friend and was initiated into the sport of surf casting with surface lures. My nine-foot rod weighed but 6½ ounces. I wore chest waders but the receding waves sucked the sand from under my heels, causing a dispute between the long and short legs, and on many occasions I nearly fell into the surging sea. However, I managed to land a 22-pound striped bass, which, as a novice, pleased me greatly. At the end of the struggle, both the bass and I were tired. It was a new experience for both of us. I walk from one to four miles about town each day, visiting the Marblehead post office and the library, and bring home supplies from the stores. I have been a pedestrian for five years since an automobile hit me as I was crossing a street. Marblehead is a beautiful seacoast town and I find walking a real pleasure—particularly when there is no ice."

From **Harold Mitchell** I received a nice long letter covering the trip he and Mildred made to Europe last August with a group of ornithologists. Harold has since been laid up with hepatitis but has now practically recovered. They first flew to Amsterdam where they toured the city, museum and zoo. Mildred is suffering from arthritis, which makes it difficult for her to walk, but thanks to wheelchairs provided throughout the trip, she missed little of the various tours. They next toured the Rhine country by bus, boat and train, and visited Coblenz, Frankfurt, Lucerne and Geneva. From there they went to Arles, near the Comangae country at the Rhone River delta, the best place for birding in southern France, here they visited a large bird banding station. "In the many fresh and salt water lagoons nearby, were a variety of shore birds and herons as well as waterfowl and even flamingos. In the surrounding woods and fields were havens for a great variety of unique land birds such as bee-eaters, rollers and hoopoes with their unusual fab-crests, all new birds to me. I also saw many birds of prey. Then on to Paris for a sightseeing tour.

"The International Ornithological Congress was held at The Hague for one week, at which some 900 bird lovers were present with about 200 from the U.S. and Canada. The program was excellent and fortunately most of the speakers used English. It was a chance to meet many people, to renew old friendships and to see some fine slides and movies of birds taken all over the world. We took a field trip to islands where many thousands of shore birds, such as plovers and sandpipers, were flying to escape the tide on the wide flats. I saw more of these birds in one day here than I have ever seen in a day anywhere in the U.S.A. One morning we took another trip to a sand dune near Rotterdam where I added crested grebe, tufted duck and many land birds to my life list. We then visited Marken and Vollendam, those interesting twin tourist traps, before flying home. We had an interesting adventure in New York at Kennedy field as the plane ahead of us on the runway caught fire, killing the entire crew and we had to fly to the Hartford, Conn. airport, where we changed to a Buffalo plane.

"On October 5-9, 1970, a meeting of the American Ornithologists' Union was held in Buffalo. As Chairman of the Committee on Arrangements, I was kept busy with the program and banquet at which over 200 were present. The last day a field trip to the Iroquois National Wildlife Refuge, to the New York State Conservation Game Management Area, and to Niagara Falls concluded a most satisfactory meeting. Best wishes to all my 1912 friends. May they live long and prosper!"

For the first time since we assumed this job of acting as your secretary, in June, 1967, you have let me down, despite some 50 individual requests for contributions. During this period of nearly four years we have been able to publish a full page of news in each issue. During the past month we have received news items from only two classmates. We know you enjoy reading about others. Nuff sed!—**Ray E. Wilson,** Secretary, 304 Park Ave., Swarthmore, Pa. 19081

13

Our air-borne classmate, **Marion Rice Hart** has again made international news while piloting her Niner Four Three Yankee (260 horsepower Beechcraft Bonanza); this time flying solo against a ten hour headwind across the Atlantic from Goose Bay to Reykjavik, Iceland. Even with a cracked knee in Lisbon, she flew to Madrid to consult a specialist. Leaving her "little Treasure" in Geneva, she returned home on a commercial airline to have her leg patched up. In December she resumed flying around Switzerland, France, and Italy. Marion flew from Naples to Tunis, then heading on toward Morocco, landed in Algiers for refueling, then on to Oujda, Morocco. Continuing her flight, she landed in Marrakesh and Agadir, then along the Sahara coast to Villa Sisneros and Nwadibhu. Marion intends to spend the winter in the African sun, flying to Kenya and Zambia, then Ethiopia and Egypt. The latest report has been relayed from Dakar, Senegal, that our girl is still on the move. The best of luck and good wishes to you, Marion on your 79th young life. Maybe she will join a peace conference in the Far East.

We are indebted to **Fred Lane** for the above story appearing in the *Baltimore Sun.* Fred writes: "Am enclosing a clipping from a recent edition of the *Baltimore Sun.* Could this be the Marion Hart of 1913? The article gives none of her early life, so I find it difficult to tell. Perhaps you can find a clue in it. Apparently the dispatch was written in Dakar, Senegal, which my atlas says is in Southwest Africa. You and your new assistant are doing a nice job on the class notes. Our best to both of you."

Jack Farwell forwarded his yearly letter and we quote: "Congratulations to the new 1913 assistant secretary; the thirteeners are very fortunate—the Capens are a wonderful team. Re: the 1971 reunion, sorry to read in *Tech Review* that prospects are not favorable. I vote for the Cape, but would be glad to go anywhere. Was sad to learn from your October-Novemb r report in the *Review* of the passing of George Dempsey. We were from the same small town, Natick, Mass., and went to school together as kids. For many reunions I was looking forward to seeing him, but as you will recall, he couldn't seem to be able to join us. As to activities hereabouts, nothing exciting to report. I should travel some, I suppose, but don't have the interest or ambition. Busy as usual with maintenance, buildings, grounds etc.—summer, tractors, mowing fields; fall, power vacuum on too many leaves; winter, snowplowing; these changes in seasons keep one busy. You are doing a wonderful job reporting to us all in the *Tech Review*—a great pleasure to hear from the classmates."

We know that all of us should be very much pleased at the rating of M.I.T. in 18 categories as recorded by a survey of the American Council on Education. . . . Our classmate, **George R. Wallace** has again shown his philanthropic achievements and loyalty to M.I.T., and we quote the *Industry Magazine:* "Dr. James R. Killian, Jr., chairman of the Corporation of the Massachusetts Institute of Technology, has announced the receipt of a gift of $300,000 from George R. Wallace, Jr., of Fitchburg which will make possible the building and equipping of M.I.T.'s first optical telescope facility. Mr. Wallace, an M.I.T. alumnus, is a retired industrialist and a noted philanthropist. The new facility will be named the George R. Wallace, Jr., Astrophysical Observatory and will contain a computer-controlled 24-inch telescope, plus a 16-

inch instructional instrument. The observatory is now under construction on a hilltop site in Westford, Mass., and is scheduled for completion next spring. The total cost of $400,000 includes funds being provided from M.I.T.'s own resources. Professor Thomas B. McCord of the M.I.T. Department of Earth and Planetary Sciences has been appointed director of the Wallace Observatory. Professor McCord is an optical astronomer and was formerly at the California Institute of Technology before coming to M.I.T. in 1968. Mr. Wallace was for many years president of the Fitchburg Paper Company. His varied activities include a long-standing interest in astronomy and in clear air turbulence. He recently donated to the City of Fitchburg the $2.4 million Wallace Civic Center which contains, besides a large convention hall and ice skating rink, the 120 seat Alice G. Wallace Planetarium, one of the most modern of its kind in the U.S. Astronaut Richard Gordon, command module pilot on the Apollo 12 mission to the moon, was the principal speaker when the facility, named for Mr. Wallace's wife was dedicated.

"The Wallace Observatory will employ a unique integrated computer control system that will improve telescope efficiency by a large factor over manual control and operation. The computer system will be used to automatically point the telescope to achieve precision accuracy in sightings, to operate and monitor instrumented experiments connected to the telescope, and to analyze experimental results. 'Our plan is to have at the Wallace Observatory a built-in versatility that will permit a flexible range of activity from observation to instruction, including the testing of new instrumentation and new methods of data handling and analysis,' Dr. Killian said. 'With M.I.T.'s special competence in physics, in chemistry, in solid state electronics, in planetary science and in computer-based data processing, the Wallace Observatory will enable faculty and students to bring to astronomy and astrophysics a whole host of new ideas and experiments.'

"Dr. Killian said the Wallace Observatory fills what has become a major and urgent need in the growing fields of astronomy and astrophysics at M.I.T. Faculty and students working and studying in optical astronomy presently must borrow time on telescopes elsewhere to meet their research and instructional needs, but interest in the field has grown to such proportions that this is no longer practical or efficient. Enrollment in astronomy courses jumped from 22 three years ago to 425 last year, Dr. Killian said. In one recent year, a research group working on solar system problems used 70 nights of observation time elsewhere, some of which the group had to schedule as much as a year and a half in advance.

"For those M.I.T. research groups whose studies will still require time on very large telescopes such as the 200-inch Mount Palomar facility in southern California, the Wallace Observatory locally will permit them to prepare and test instrumentation and experiments in advance and thus make more efficient use of their allotted observational times when available. Wallace Observatory will be linked electronically with M.I.T.'s 120-foot radio telescope located at the Haystack Observatory in nearby Tyngsboro, Mass." Yes, George, you and your charming wife, Alice, have been responsible for many beneficial projects in Fitchburg and other towns and institutions. As a banjo and organ player we are very proud of you.

It is with very heavy hearts, that we announce the death on February 12, 1971 of our friend, Henry R. Kane, Class of 1924. "Chick" was an electrical engineer with the Boston Edison Company, then an administration assistant to President Karl T. Compton. He was appointed the first Director of the Alumni Fund. "Chick" was one of the outstanding alumni and a friend of all of us that knew him. We shall miss him with his wonderful sense of humor, and his talents, such as his nature writings, photographs and drawings.

We have received a notice from the Alumni office that our classmate, **Frederick O. Stillman,** 53 Post Boulevard, Carteret, N. J., has passed away. To the Stillman family we extend our most sincere sympathy. We are sending a card of condolence.

To you all, Roz and I extend our best wishes and we are looking forward to hearing from you.—**George P. Capen,** Secretary and Treasurer; **Rosalind R. Capen,** Assistant Secretary, 60 Everett St., Canton, Mass. 02021

15

When you read this column, it should be spring. A relief from the worst winter we've had here in a long, long time. Lucky those "snow birds" who have basked in the South or the Caribbean all winter.

As President of Roosevelt Hospital in New York City, **Jerry Coldwell** spends at least two days each week there, supplemented by working with some charitable activities .That's a dedicated and worthwhile use of retirement time. Nice going, Jerry. . . . **Durger Doane** has moved from Florida to Reading, Mass., to live there with his married daughter, a widow. He is anxious to get together with **Ray Delano,** The Pirate and some of the old Course I crowd. Summer school did a lot to bring and keep Courses I and XI together. Comes the good weather and we'll try to set up something for them. Meantime, our April 20 Boston Class Dinner at the M.I.T. Faculty Club here, will bring all the local crowd together again.

Long time no hear from **Peter Hooper** until in January I received a card from him mailed November 1, in Capetown, South Africa: "I am having a wonderful time touring Africa with my son, Peter, Jr., who is the #2 man in the American Embassy in South Africa. His tour of duty here is over and we are on a three-months' tour of Africa from Capetown to Casa Blanca. From there we'll go to Spain, Portugal and the Grand Bahamas, spending about one month on this part of the trip. I have found the people here most hospitable. Regards to all Classmates." What an experience! . . . Tears for poor **Jim Tobey,** who taunts us every winter with his "suffering" on that Platinum Coast of West Palm Beach in the 80° surf. On February 1 he returned prematurely early, to his new address at 15 Purchase St., Rye, N.Y. 10580 to suffer, really, in the 6° miserable weather up here. . . . After the big Southern trek was over, early in February Mona and **Clive Lacy** made it to Orlando, just in time to avoid some more of our miserable winter here. . . . Good **Frank Boynton** writes from away out there in sunny California about the interesting meeting he attended with the fine chance to meet President Johnson. Frank wrote on February 3: "My friend Bob Bartz, 1944, recently took me to a meeting of our local M.I.T. Alumni Club at the Hilton Hotel in Beverly Hills. It was well attended by an enthusiastic audience, many of whom looked of the elder variety from Classes in the 20s, 30s, 40s. President Johnson made a fine impression and seemed to know in great detail what the campus problems are and how the Institute is facing up to them. Prior to his address, I had a chance to shake hands and say a few words with him. Needless to say, I was highly gratified. I looked for our classmate, **Bob Welles.** I spoke with him later and also to Hiram Beebe, 1910. Back in the 50s Hiram and I were both members of the Western Bird Banding Association. Salutations and all that to the 'Supreme Secretary'." Thank you, Frank, and good to hear from you. Write again. . . . If you haven't already paid your class dues—how about it to "help Azel."—**Azel W. Mack,** 100 Memorial Dr., Cambridge, Mass. 02142

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Your secretary expresses his appreciation for the many intriguing get-well cards, and more recently for the Christmas and birthday cards and notes from classmates. He also notes the yeoman work of the assistant secretary who, with Dolly his wife, is getting away to the Caribbean at the end of March for peace and quiet and no mailmen for a while.

On a Christmas card to Harold Dodge, **Willard Brown** writes that he and Dorothy spent a few days at Ben Brown's, a new resort at South Laguna and arranged to have dinner with Kay and **Irv McDaniel** at their club at Rossmore Leisure World (where **Ken Sully** also lives). Five-letter special license plates are now possible in California and Willard is contemplating following **Ralph Fletcher**'s lead and getting one to read "MIT16". . . . A letter

from **Ed Parson**'s brother Dick (Class of 1926) supplies an item about **Van Bush** that we can't resist: "one morning Van made this opening address to our class: 'Last night an unusual thing happened to me. About nine o'clock my lights went out. I called the Light Company to report it, and a very polite man asked me to give my name and address, which I did. He then said, "Are you by any chance the Vannevar Bush that wrote *Principles of Electrical Engineering* by Timbie and Bush?" Van said, 'My breast swelled with pride, and I said *Yes.* My new acquaintance on the other end of the line then said, "I am going to night school, and we are using your *Principles of Electrical Engineering,* by Timbie and Bush, and I don't care if you never get lights." ' Van was fun to be with."

Jim Evans forwarded a letter with reprints regarding cancer from **Dick Berger** who writes that he has retired from regular employment but is active in Non-Profit Cancer Prevention, Inc.

A letter from **Clint Carpenter** gives the latest news about his family: "Not much of an unusual nature to relate except that Phyllis has been incapacitated since October 11 with a broken ankle. The cast was removed yesterday however, which is a very welcome relief to her and particularly just before Christmas. Daughter Sylvia still operates her book shop—The Virginia Beach Book Shop—in which she takes great interest. Jerry (M.I.T. '54) is running the construction business and keeping busy with a slight assist from me. Grandchildren, Courtney, 8 years and C. Clinton 2nd, 4 years are really wonderful. So, altogether we are exceedingly fortunate."

A clipping from the *Boston Herald* of December 1, 1970 was sent us showing Colonel **William Drummey** being presented with the Colonel Paul Hines Award of the Crosscup-pishon Post, Legion Advertising men. . . . We were included in the distribution of a five-page Christmas letter to his friends from **Vic Dunbar** who writes from his home in Sackville, New Brunswick, where his son Don is teaching. The letter details a trip in the spring to the Bible lands and Greece, with many references to locations referred to in the Bible and elsewhere. Attendance at a summer session at Dartmouth provided the opportunity for many excursions in Maine and New Hampshire and Massachusetts to visit old friends and places, some of the latter being hardly recognizable. As this digest doesn't do his letter justice the original will be at our 55th reunion, which, in case you haven't heard will be at Chatham Bars Inn on the Cape, June 8 thru 10, 1971. . . . A happy recovery from a coronary insufficiency in October is reported by **John Fairfield.** He is active now but needs help for storm windows and snow shoveling as do we all. Previously he took a trip to Nova Scotia and Cape Breton. Many changes were noted from previous trip twenty years ago—express highways, motels, campers, trailers and hitch-hikers, but the meals were better.

Here's one from the distaff side that has a "heads up" appeal to this scribe: **"Ralph Forsyth** has given me permission to answer your call for 'Help'. These requests have been ignored in the past because there just isn't anything to say! As to your 'suggested topics': 1) What have you been doing: (Referring to Harold Dodge's reproduced plea for news complete with sketches) If the figure with the cane were female it would be I. The one in the rocking chair is Ralph. 2) Where have you been or are going: We fly to Pocasset, Mass. in June, and fly back here to Naples, Fla. in October. End of 'been' and 'going'. 3) Who you've seen: Phil Coffin, Class of '21 lives in this area (Naples) in the winter and we see him and his lovely Edna from time to time. 4) What the children or grandchildren are doing: We haven't any unfortunately. 5) Bit of Philosophy: Be happy if you wake up in the morning. Ralph had a coronary two years ago and we have been leading a very quiet life since then. However he looks well and does remarkably well. Now we don't expect you to print any of this but your letter was so desperately appealing, I felt this once we should answer and let you know we are breathing, though not in any sense very active."

Another Christmas card was received from **Robert Kallejian** which proclaimed Peace and Joy from Whittier, Calif. . . . **Charlie Lawrance** reports a safe return from his "Grand Tour" to California and other points of family interest in between.

Proud grandparents indeed! Miriam and **Merrick Monroe,** our newest for-the-first-time grandparents of Noroton, Conn., report a flight to California on December 21 to spend the holidays with son, Dr. John now interning in a 3000-bed V.A. hospital in the Westwood section of Los Angeles, and wife Candy, and five-month-old baby Elizabeth, "A real doll". They flew out and back United but things surely were not crowded—only one-third occupied going out and about ten to fifteen per cent occupied coming back. "No wonder" say M. and M., "the airlines are losing money." Speaking of grandparents, Frances and **Paul Duff** wrote at Christmas time that their youngest son Brandan, was back in the U.S.A. from overseas in early December and was visiting his brother and sisters on the way home. They indicated: "Our family picture is lovely—there are 55 of us now, everyone of them came for our 49th Anniversary, and we had lots of fun."

A note to **Jim Evans** from Nina D. Pollard, long time secretary and golf partner of **Duncan Owler,** notifies us of his death on December 18, 1970, 36 hours after he suffered a heart attack. He was president of the Fall River Light Company from 1954 until his retirement in 1957, and was chairman of the executive committee at the time of his death. He had served with the company for 43 years.

We are indeed sorry to report the death of **Irving McDaniel.** He had suffered a number of strokes and finally passed away on February 22, 1971. His devotion to the Class was really noteworthy and he will be greatly missed.

Henry Shepard reported just before Christmas that he and Frances were busy as usual with their winter activities. "We both bowl and I curl three or four times a week. Our children and their children are nearby so we had 18 here for Thanksgiving and expect 16 for Christmas." . . . **Francis Stern** writes from his winter home in Palm Springs that he is in the ideal place to clear up an infection that has been bothering him all fall. Gets to play golf now and then and enjoys the 70 degree temperature that is typical out there. . . . In response to the Alumni request for news at the time of the annual plea for contributions, **Maurice Strieby** reports that his wife broke her hip and had a heart attack from which she did not recover and passed away on January 6. Our deep sympathy to Maurice from all his classmates. . . . Via the same route **Ken Sully** writes: "Congratulations on the good picture of the 54th Reunion appearing in the current *Tech Reviews,* which reminds me that we'll be there next June for the 55th."

Mildred and **Art Shuey** have reported on their trip starting in February last year to Tahiti and the South Pacific. They saw New Zealand "from top to bottom." In Rotarua, Art caught his biggest rainbow, five and a half pounds. "Most everywhere that Queen Elizabeth landed to celebrate Captain Cook's discoveries, we were there to greet them. The South Island was beautiful and we went from Christ Church to Milford Sound and back by way of Mt. Cook to Christ Church and flew from there to Melbourne, Australia. Visits with friends in several places in Australia were followed by an appointment with an astronomer at Sidney Observatory where Mildred had a session with a 1867 telescope and viewed the Southern hemisphere sky. After such visits, Fiji, Samoa and Hawaii were pale places." They plan a trip in March to Rio, then to Johannesburg, Capetown, Durban, Victoria Falls, Kenya, Addis Ababa, Athens and Grecian Isles, Istanbul, Vienna, Amsterdam and home in time for the 55th reunion on Cape Cod."

We have word from another traveling couple, Sylvia and **Vert Young,** back from their round-the-world travels including South Africa and Australia, where they collected what Art Shuey calls "at least a ton of rocks but no diamonds." Vert says "We are thinking of going on to Quebec after the reunion, taking the Canadian National to Jasper, and then by bus down through Canada to Glacier National Park, Great Falls, the Yellowstone, Grand Tetons and on to Boulder, Colorado. Sounds great, if we can make it!" . . . A third knowledgeable and wide-traveling couple is none other than Vi and **Herb Mendelson** of New York who wrote in January that they were "off to Tahiti, Fiji, New Zealand, New Guinea, Samoa, Hawaii. Have a number of mis-

sions to perform for the Peabody Museum of Natural History (Yale)—photos, movies of native life, unadulterated by so-called Western civilization." We hope to hear more about it later.

Some of the notes submitted for this issue may have to be held over for the next issue due to space limitations in the *Review* and the generous response of our classmates to our pleas, for which the class is duly grateful. But do continue to write often your Secretaries who will be only too happy to spread the word.—**Harold F. Dodge,** Secretary, 96 Briarcliff Road, Mountain Lakes, N.J. 07046 or **Leonard Stone,** 34-16 85th Street, Jackson Heights, N. Y. 11372

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We finally pried out of **Ray Brooks** an item about his W.W.I Smith IV, #20 Spad airplane in custody of the National Air Museum of the Smithsonian Institution, to wit: "After the armistice my 22nd Pursuit Squadron was held at Coblentz for possible occupation duty. While there, orders were received for two of our buses to be sent to the States for exhibition and Liberty bond drives; the machines had only to be in good flying condition, having suitable air battles and kills.

"I understand that the crates did their work in the U.S. as intended but whereas one was cracked up, my old Smith IV, to my surprise, finally ended up in the hangar building of the Smithsonian. Really, Eddy Rickenbacker's Spad should have been there but his was burned up, post armistice, in the pyres at Colombey-les-Belles Air Depot. What was wanted, evidently, was an authentic French-produced fighter plane, predominantly used by the American Expeditionary Force in France in 1918. Mine happened to be available for the purpose to present a Type XIII Spad with 220 horsepower Hispano-Swize water cooled engine and having 2 Vickers .303 cal. machine guns. This was the same aircraft as developed after August 1917 by the French and used by the crack squadrons of the air arm of the French Army. Smith IV had three kills—one by me (out of six) and two by Clinton Jones (whose total was eight) using it while I was in the hospital.

"Incidentally [I flew] Smith I when I was in the 139th Pursuit Squadron. Then, in the 22nd Squadron, Smith II was shot to pieces and Smith III had to be salvaged after a forced landing ending in a shell hole at Verdun. As to the name itself it stood for Smith College where I had left my best girl, Ruth, who later became my dear wife."

Our honorary classmate **Buzz Aldrin** was the principal speaker at a symposium, "Lunar Science in Progress" sponsored by the Harvard-Radcliffe chapter of the Society of Sigma Xi in Cambridge on February 18. Susan and **Al Lunn** attended (as did Jacquelyn Findlay of the Alumni Fund Staff.) After introductory talks by three Harvard professors on lunar minerology and soils and also evidence for the absence of life on the moon, Buzz opened his remarks by narrating a film showing scenes from the flight of Apollo 14.

Buzz continued his comment by pointing out some of the highlights in the rigorous pre-flight training of astronauts, particularly the underwater exercises and the flying parabolic maneuvers in jet airplanes. He discussed many of the complex instruments used in flight and those set up on the lunar surface. He described briefly the classes of rocks which he saw and brought back and the metals and minerals which were present. One of the significant problems on the lunar surface was the navigation and the ability to estimate distance. He stated that the lunar flights represented milestones in man's quest for knowledge and are of inestimable value in convincing the world that we are maintaining our supremacy in space exploration. Discussion of the programs for Apollo 15 and succeeding flights and the possibility of improved instrumentation to obtain even more significant data all made a fascinating evening.

With regret recording is made of the deaths of two of our classmates. Colonel **John C. Platt** died at Van Nuys, Calif. on September 5. **Erling B. Stockman** died at Damariscotta, Maine on December 6. After 30 years with Consolidated Edison in New York he had retired to Maine in 1966.

A practical memorial for **Ed Tuttle** has been made at Dublin, N.H. Ed's excellent machine shop equipment has been given to a friend who has set it up in the town center for himself and all to use.

These address changes make it look as though 1917 is on the move. G. Radcliffe Stevens to 573 N. Melrose Ave., Elgin, Ill. 60120; Samuel J. Zeigler to 4360 Ivymount Ct., Annandale, Va. 22003; Rolf A. Schroeder to 17 Bowker St., Brookline, Mass. 02146; George R. Duryea to Mt. Lake, Lake Wales, Fla. 33853; Norman F. Stevens to 1145 Barnam Dr., San Marcos, Calif. 92069; T. W. Burkhart to 4708 Fieldcrest Ave., Milwaukie, Ore. 97206; Alfred Pierce to 3737 Atlantic Ave., Apt. 1212, Long Beach, Calif. 90807.

Only **Will Neuberg** and **Clarence Seely** got to the '16-'17 New York February lunch as the **Richard Loengards** were still in the Virgin Islands.—**Stanley C. Dunning,** Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard O. Loengard,** Assistant Secretary, 21 East 87th St., New York, N.Y. 10028

18

At my vantage point, close to our Alma Mater, I see and am able to report to you many of the varied and little-publicized ramifications of what is going on at M.I.T. Recently at a luncheon meeting of the M.I.T. Club of Boston, I found my immediate neighbor to be Leslie Boring, a graduate of the Class of 1964. He turned out to be the Director of M.I.T. Associates Program. And what is this? It is a program to emphasize the importance of an interaction between M.I.T. and industry. It provides member firms access to the Institute's educational and research programs. At the same time, the faculty and staff gain insights based on industrial experience, M.I.T. benefits with the fees paid by the participating companies. I believe many an alumni controlled enterprise can profit by being involved in this program.

I was happy to see **Harold Weber** recently at the M.I.T. Faculty Club. In retirement, he leads a busier life than ever, as you will note from his biography. He is particularly interested in his old love Course X at M.I.T. and is giving much thought to maintaining and improving its high quality. His biography follows herewith: "In 1917 when the United States got into the war we were juniors at M.I.T. I had been a radio amateur for several years so the Army moved me out as a student and into what was the aviation section of the Signal Corps—there was no Air Corps. As a civilian, I was assigned to teach radio and artillery spotting at the ground school at M.I.T. This lasted about nine months—then the ground school was closed. I was commissioned a second lieutenant and sent to a flying school in Louisiana. Soon after this the Chemical Corps was established and being almost a chemical engineer, I was transferred to Chemical Warfare in Washington to work under Lewis and Walker. In December 1918 I was discharged from the Army, went back to M.I.T. to finish up my training as a chemical engineer. This took about four months. At that time, Doc Lewis started a consulting firm known as Lewis, Green, McAdams and Knowland. He had all Tech men working for him. I did join this group, but the venture lasted only until about 1920. When it broke up I went to work at M.I.T. as an Assistant Professor in Chemical Engineering. I gradually worked up to the position as full Professor and retired because of age in 1960. Meanwhile, several things happened. In 1933, I took a year's leave of absence and went to Switzerland for an Sc.D. at the Erdgennosiche Technishe Heckschule in Zurich. From Zurich I wrote to Professor Kumlmeyer in the German Department at Tech that instruction in the German language should include instruction in everyday spoken German, since in Zurich, I had difficulty in purchasing such items as toilet tissue and coat hangers. Back in the United States in 1935, I returned to teaching and gradually built up a consulting practice. During the years there were several trips to various parts of the world. Finally in 1958 the Department of Defense asked me to go to Washington as Chief Scientific Advisor for the Army. I went on part-time at M.I.T. and commuted back and forth between Washington and M.I.T. until 1966. By this time I had been retired from M.I.T. Dur-

ing the years, I picked up several decorations from the Army and an honorary Sc.D. from Suffolk University in Boston. I wrote a book on thermodynamics which for many years was used as a text in most Chemical Engineering Departments in the United States. I also contributed the sections on thermodynamics and refrigeration to two editions of *Monks Mechanical Engineers Handbook*. I still carry on a consulting practice; one of my clients being Universal Oil Products Company of Chicago, for whom I have consulted for 43 years. I get to Washington on government work a few times a year and occasionally my wife and I take a trip. Now we live comfortably in Boston during the winter and spend summers at a little place we own in New Hampshire."

As some of you know—and will know—I do all I can by asking you directly and by devious and subtle ways to get your stories. I am grateful for the most interesting response from **Ted Braaten.** (Will more of you follow suit, please.)

"Dear Max, Thanks for your letter of January 11th. I don't know how interesting this will be for our class notes. Hope it isn't too long. I finished my Course VI requirements in early summer of 1920 and on July 16th married Eunice Eddy, 'Boston's youngest newspaperwoman and Radcliffe's prettiest senior,' as one Boston newspaper reported it. This last July we celebrated our 50th with a big party of family and friends. We tried to keep our marriage a secret but Professor D. C. Jackson apparently got wind of it because he called me at the New York Telephone Company where I was working and asked me if I would like to come back to Tech to teach 'triple E.' I jumped at the chance, of course.

"The following year I studied hydroelectric engineering in Norway on a fellowship from the American-Scandinavian Foundation. Eunice and I worked our way over to Oslo (then Kristiania) on the old Bergensfiord which turned out to be an exciting adventure. In a deep fog the ship collided with an iceberg in the north Atlantic and had to limp along on one propellor the rest of the way.

"The remaining part of my professional career was spent in the electric power field—three years with the Public Service Company of Northern Illinois as substation operator, generating station operator and system operator; twelve years with Westinghouse Electric Corp. as switchgear engineer in East Pittsburgh and central station engineer in New England; five years with the Boston Edison Co. as Assistant Head of Station Electrical Design Division; and finally, after the war, fourteen years as general manager of the Department of Public Utilities in Norwich, Connecticut.

"I served as an officer in the European Theater in both World Wars. In World War II I was stationed in London for a year and developed a deep and abiding respect for the British. Although I lived through many bombing raids in 1943 and 44 they were mild compared to the ones the people suffered in 1940 and 1941. Later, on the continent, I served with a group of utility specialists under the direction of SHAEF. My duties until after V.E. Day consisted of directing the restoration of public services for Army needs, as soon as these were uncovered. I was responsible for placing in operation the steam power plant and distribution system in Aachen, Germany; also for restoring some 70 miles of 150,000 volt transmission lines in Holland. I made a survey of public utilities in the Ruhr. After the capitulation of Germany I was ordered to Norway as Chief of Public Utilities SHAEF Mission Norway. I was later transferred to Berlin, Germany, and made Chief of Public Utilities, U.S. Hqrs., Berlin District. I am a retired Lieutenant Colonel U.S.A.R.

"I always said that I would retire at age 65 and I did just that 11 years ago. It was the best decision I ever made, although I must admit that at times I feel a little guilty being part of what is really a racket. I try to soothe my conscience by actively supporting the American Red Cross, (past chairman for two years) the Salvation Army, the United Fund and the March of Dimes (past chairman). I was a vestryman of Christ Episcopal church for some years, but all I do now is sing in the choir. I am an active member of the Connecticut Society of Professional Engineers (past president) and the I.E.E.E. (past chairman of Conn. section A.I.E.E.). I am a Rotarian. My hobbies are loafing, golf, bridge and the SPEBSQSA, Inc. Eunice and I both like to travel and since my retirement we have twice sailed round the world; round Africa; down the west coast of South America and up the east coast; toured most of Europe by car, and visited London nearly every year. In retrospect, I would say that three of the high spots in our memories are Buenos Aires (where we stayed three weeks) Christchurch, New Zealand (ten days), and the island of St. Helena (four hours). Last year we spent six enjoyable weeks in Magaluf, Majorca, and will be there again this year after a week or so in Yugoslavia. We shall end up, as usual, in London.

"Our family includes two sons and five grandchildren. Our older son, Ted, graduated from Swarthmore after a stint in the Air Corps in World War II. He is now Director of Subscriptions for the *Reader's Digest*. Our other son, David, was also in the service during the war, as an infantryman, then graduated from Harvard, put in four years as a diplomatic courier, and is now a reporter and columnist for the *Washington Evening Star*. We have spent most of our summers since 1935 in our very small shack at Peaked Hill Bars, on the outer beach at Provincetown, Cape Cod. Cordially, Ted."

A note, dated January 25 from Marie **Sackett** reported that **George** suffered a stroke in January and that he is making good progress towards recovery at the hospital. I hope he is now home and back to normal good health.

Recently a letter appeared in the *Boston Herald Traveler* supporting legislation to enable Massachusetts to join 43 other states which have a title and auto theft law. I am sure the signature of **Herbert L. McNary,** Legislative Counsel, is that of our own Herb. Good work!

A clipping in the February 2 *New York Times* records the death of **Joseph Herzstein,** as follows: "Dr. Joseph Herzstein, an internist who specialized in cardiology, died yesterday at Mount Sinai Hospital, where he had served on the staff for 38 years. He was 77 years old and lived at 175 East 79th St. Dr. Herzstein was in the Public Health Service from 1913 to 1917, after his graduation from City College. He received an M.S. from the Massachusetts Institute of Technology in 1918, and an M.D. from Cornell University Medical College in 1924. A native New Yorker, Dr. Herzstein was in private practice here for 45 years. He was on the staff of Beth Israel Hospital where he engaged in cardiological research. He is survived by his widow, the former Rosella Kerner."

John W. Gustaveson has a new address: W. 440 Worall Road, Kansas City, Mo. 64114. Keep the news coming to me.—**Max Seltzer,** Secretary, 60 Longwood Ave., Brookline, Mass. 02146

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A note from **Chuck Drew:** "To Gene Smoley—Greetings—sorry to report the passing of two of our 1919 classmates, **Fred Barney,** Hendersonville, N.C., just before Thanksgiving and **Louis A. McCarthy** just after. Louis lived in Minneapolis and Milwaukee. I'm partially retired, aiding Mrs. Drew who is ill. I'd love to greet you in Florida but that is not in the cards now."

William F. Saunders, Jr., of St. Louis, Mo. passed away on November 4, 1969 according to the Alumni Records notice of January 11, 1971.

Your secretary talked to **John Stevens** who spends his winters at Village of Golf, Boynton Beach, Fla., and will see him shortly. . . . **Doc Flynn** came through Delray Beach on February 1, returning from a honeymoon in the Caribbean with Irma from Lehighton, Pa. We had dinner and a nice visit together and Doc has taken on a new "lease on life."

An article dated October 15, 1970 from the *Monadnock Ledger,* Jaffrey, N.H. came from the alumni office about Colonel **William H. Bassett** and his career. One interesting item was that Bill, while with Coe Brass (later Anaconda) made up a special aluminum bronze piece of equipment for an airplane and later learned it was used on Lindbergh's flight to Paris. Another item was his part in getting together 40 boats which were used to form a pontoon bridge which tanks crossed over for the invasion at Inchon under General MacArthur.

E. W. Noyes, Sr., '21.

Your secretary does not receive enough news and urges you to write. Our seventh grandchild, Rebecca Louise Hodgkin arrived February 8, 1971 in Baltimore. The weather has been very good in Delray all this winter—**E. R. Smoley,** Secretary, 50 East Road, Apt. 11E, Delray Beach, Florida 33444, Phone 305-278-4537

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Those noted world travelers, Hannah and **Harry Kahn** have bobbed up in the Philippines where they are serving their third assignment for the Fil-Hispano Ceramic industry. Harry says that at the moment conditions are a bit rough what with a strike of taxi, bus and jitney drivers plus a strike of students. However, the Kahns are planning to stick it out for from three to six months, after which they will no doubt return to their home in Uxbridge, Mass. for, at least, a short stay. Harry sends regards "to all 1920 men."

Like many another classmate, **Bill Honiss** has ducked the N.E. winter for his winter home at 272 Key Palm Road, Boca Raton, Fla. Not wishing to buck the trend your secretary and his Amy are presently in Greenbrae, Calif., north of the Golden Gate, where spring is going full blast. Hopefully by the time they get back they will encounter a second spring this time in New England.

The class statistician has asked me for a census of class great-grandchildren. Have you any candidates? If not, fellers, would you be so kind as to come forth with anything to relieve the shortage of news? And that goes for you, too Dorothea.—**Harold Bugbee,** 21 Everell Road, Winchester, Mass. 01890

21

Exactly nine weeks remain from the date of this issue—a mere 63 days—to the outstanding event in the history of the Class of '21, our 50th Reunion in Cambridge from June 3 through June 7, which includes Homecoming '71 at M.I.T. We have oft repeated admonitions to make travel plans for your wife and yourself; to obtain reunion reservations from Reunion Chairman **George A. Chutter** (address at end of these notes); to secure Homecoming tickets from the Alumni Association and, above all, to order your special M.I.T. 50-year class cardinal blazer per the instructions you should have. With these important matters settled, you can sit back and enjoy the anticipation of a happy vacation with your best friends on earth. If you did contact George, you now have the Reunion and Homecoming schedules with full details of the many pleasurable events crammed into those five days. You won't want to miss this occasion which comes our way only once and which is permitted to only a few. If you haven't taken action, be sure to do so now before it is too late. Join '21 in 'Seventy-one!

Secretarying in Sarasota

Writing from their winter sojourn in Sarasota, Fla., Betty and Assistant Secretary **Sumner Hayward** tell of visiting his roommate, Hobart A. Fischer, '22 and his wife in Daytona Beach on the way down. Driving back, they stopped to see Celia and **Frank E. Huggins, Jr.,** of the once-famous 4-H club of '21, at their new home, Coffin's Point Plantation, Frogmore, S.C. 29920, north of Savannah in the Carolina Sea Islands. The Huggins couple are reported to be busy planting and maintaining an acre of varieties of flowers, enjoying the beach and entertaining relatives and friends. Sumner says, in part: "I phoned Claudia and **Josiah D. Crosby,** 3310 Sheffield Circle, Sarasota 33580, on our arrival.

"We learned that Millie and **Herbert A. Kaufmann** had bought a condominium at 38 Sandy Cove Rd., Sarasota 33581, at the north end of Siesta Key. We stopped to see them in their delightful place overlooking a salt water pond in which a great blue heron was feeding from mullet. The Kaufmanns have sold their Pound Ridge, N.Y. antique shop but still own the home at 41 Banksville Rd., Armonk, N.Y. 10504 where they will stay for six months in the summer. Herb has been in touch with Alice and **Robert M. Felsenthal,** 7 Woodcock Lane, Westport, Conn. 06882. Both couples will attend our 50th." Sumner sent us an attractive menu from the Oyster Bars Restaurant signed, with appropriate and appreciated notes of greeting, by the **Crosbys, Haywards** and **Kaufmanns** who gathered for a miniature '21 reunion there.

Sumner continues: "I phoned **Larcom Randall** and **T. Dillwyn Dutton** and **Richard J. Spitz** to invite them to join us. Dut, who lives near the Crosbys at 3379 Sheffield Circle, was at a Shriners' meeting. I dropped in to see Lark at the new condominium which he and his wife bought at Gulf Haven, Apt. 52, 5860 Midnight Pass Rd., Sarasota 33581. They sold their home in Wellesley and this is now their permanent address. Lark continues to make use of the cottage on Lake Winnipesaukee, where they spend three or four months a year. His place is across the lake from the Appalachian Mountain Club camp at Three Mile Road and he said he would have come over by boat had he known Betty and I were at the camp. **Dick Spitz,** who lives on Longboat Key at 100 Sands Point Rd., Sarasota 33577, said he will join us at a later meeting."

Sumner recounts news of Hazel and **Whitney H. Wetherell,** 1 Russell Drive, Harwich, Mass. 02645, who built a new retirement home there from Whit's design and under his construction supervision. Hazel and Betty Hayward are both Simmons, '23. According to our records, Whit has the distinction of being the youngest in the Class. Anyone want to argue? Sumner says he recently saw Genia and Nelson C. Lees, '53, Administrative Director of the M.I.T. Development Office. Nelson, who is the son of the late **Cornelia Nelson Lees** of our Class, reported the M.I.T. campus to have been "wonderfully quiet" throughout the fall term. For confirmation and interesting sidelights, we recommend that you read the report of a talk to the Alumni Advisory Council in January by J. Daniel Nyhart, Dean for Student Affairs, on the subject "Today's Campus: The Turned-off Generation," on p. 104, this issue.

Takeoffs and Landings

We never cease to marvel at the facility with which our "keenagers" adopt the idea of a change to a new residential locale and then adapt to the differing aspects which it presents, whether retirement is involved or solely a more

C. H. R. Johnson, '21.

satisfying domicile for further "executive loafing." This month's reports of moves to new home addresses—which should be entered in your copy of the Class Directory to keep it current—include one for **Glenn E. Fargo** at Apt. 238, 5575 Gulf Blvd., St. Petersburg Beach, Fla. 33706. Have you retired from the presidency of the Fargo Co., Glenn? . . . **Llewellyn B. Griffith** now wants his mail addressed to P.O. Box 5271, Austin, Texas 78703. Grif formerly headed his own civil engineering firm, the L. B. Griffith Co., Arlington, Va. . . . **Richard H. Morris** carries on editorial consulting work for his own firm, Tech Publishing Co., from his home at 2416 Third St., Santa Monica, Calif. 90405.

Edward W. Noyes, Sr., has changed his winter address from Stuart, Fla., to 621 Fairwinds Drive, Nokomis, Fla. 33555, where we assume he has better facilities for his boating hobby. He still maintains summer home in Thompson, Pa.

Norborne L. Rawlings, retired Navy rear admiral and former general manager and chairman of the executive committee of Newport News Shipbuilding & Dry Dock Co., gives a new home address at 23 Museum Drive, Newport News, Va. 23601. We take this to indicate his retirement.

Reunion Chairman reports

"Marion and I made a trip which included M.I.T., visiting Helen and Class President **Ray St. Laurent** in Manchester, Conn., and Wini and **A. Royal Wood,** Hamden, Conn." says Reunion Chairman **George A. Chutter.** He adds: "The Woods have since gone to Sarasota, Fla., for a few weeks. We are beginning to get high praise for the reunion jackets. I took mine to the last reunion committee meeting and found that it fitted or nearly fitted several there. Marion and I were dinner guests of Mildred and **Donald B. McGuire** at their home in East Brewster, Mass., and we spent much of the time projecting our festivities in June. Again, the jacket was admired. Don has excellent color slides of Canada, the Rockies and the western national parks. I saw **Ed Dubé** in early February. He has recovered remarkably well from his automobile accident in November but it will still be several weeks before he can drive. Emma and **Leon A. Lloyd** of Westerly, R.I., expect to be in Florida for about six weeks and also will visit with a daughter and her family in Atlanta, Ga.

"I have received the following from **Glenn H. Easton,** retired Naval commander: 'I note the *Review* says I have deserted South China, Maine, for a winter home at 1953 Lake Sue Drive, Orlando, Fla. 32803. I still own the waterfront summer home on China Lake which we built while I was at Bath Iron Works. We also own the home in Florida but are planning to sell it and move to an apartment. I am on the membership committee of the University Club of Winter Park, Fla., which has more than 20 M.I.T. graduates as members. I am the sole representative of the Class of '21. There are no '21 men in the list of M.I.T. alumni officers in Florida. I would like to know if there are any members of '21 in Florida.' He says he will be in Maine during July and August," adds George. Thanks, Glenn. We might note that, in the absence of your personal data sheet, it is impossible to interpret the degree of permanence inferred by the Alumni Association's terse notification of a change in home address. Perusal of the Class Directory you received will indicate a large segment of the Class living throughout Florida. Supplementing that information, many permanent or temporary residents are referred to in these notes almost every month.

Mailbag memoirs

"I am happy again!" is the exuberant comment of **C. Harry R. Johnson,** Box 318, Lakewood Club Estates, Point Clear, Ala. 36564, in sending us year-end greetings. Harry says: "Since writing you last, I married Mrs. Grace D. Murray, one of Mrs. Johnson's dear friends whose husband I knew very well. Mrs. Johnson and Mr. Murray died in 1967. The Murrays had lived here and in Mobile across the bay. I can quote one of our Point Clear friends who said: 'It was the nicest thing that has happened in a long time.' " Harry is the retired president of Consolidated Packaging Corp. of Monroe, Mich., and Chicago. Congratulations and best wishes! . . . Madeline and **Ralph M. Shaw, Jr.,** 137 E. Warren St., Beverly, N.J. 08010, tell of the marriage of their daughter, Mary, to Vincent Carretta. The young couple are receiving congratulations at their home near Madeline and Rufe in Beverly. The latest letter from the Shaws is on the stationery of the Sandy Lane Hotel, Barbados, where they frequently spend a late winter vacation, and it includes a much-appreciated and handsome gift of a full set of the latest issue of Barbados' philatelic gems in mint condition.

Rufe reports a lengthy discussion on M.I.T. campus activities and the agreement reached for their solution with fellow-guest John A. West, Jr., '39, and dares us to print it! *Review* standards prescribe the use of such material in sections other than in Class News, Rufe. To evaluate your conclusions, we recommend you read Dean Nyhart's views, previously mentioned in these notes. The Shaws had dinner with Edna and **Philip T. Coffin** Apt. 103, 1950 Gulf Shore Blvd., Naples, Fla. 33940, when they went through Florida. Our sincere thanks, Rufe, for being such a generous and helpful correspondent. . . . An earlier letter from Edna and Phil, sent from their summer home, 344 Jefferson Drive, Pittsburgh, Pa. 15528, told of visiting two of their married children in California last year. Phil adds: "I was most grieved to learn that Frank D. Gage, '22, of Long Beach, Calif., died while we were preparing for the trip. I might have seen him before he passed away had I known of his condition."

More manuscripts

One of the many who have done an outstanding job on **Irv Jakobson's** 50-Year Gift Committee in contacting '21 men to promote special giving and 50th Reunion attendance is **Richmond S. Clark,** P.O. Box 1400, La Porte, Texas 77571. He writes of rewarding communications with the dozen or more of the Class listed as Texas residents. Rich tells of his improved health condition that enabled a four-day trip to Austin, with Mary Louise doing the driving, for attendance at a district board and staff meeting of the Coast Guard Auxiliary of which he was a former staff officer. The Clarks have limited the duration of their trips aboard their boat. They plan to fly to Cambridge for the reunion if the medicos approve.

To supplement their earlier itinerary, Betty and **Dugald C. Jackson, Jr.,** Tetra-

stremma, Harmony Hills R.F.D. 2, Havre de Grace, Md. 21078, have furnished a detailed account of their 1970 travels to see the Passion Play in Oberammergau, then Austria, Switzerland, Turkey, the Greek Islands, Yugoslavia, Italy and return by steamer. Dug's pet peeve seems to be the Orient Express! . . . Graciela and **Helier Rodríguez,** Apt. 10-C, 4015 Bayshore Blvd., Tampa. Fla. 33611, report having dinner with **Ollie Bardes** and his family at the Bardmoor Country Club, Largo, Fla., and spending the evening at his nearby home.

In Memoriam
The Alumni Association has recorded the passing of four members of the Class of '21. We express to their dear ones deep sympathy on behalf of the Class.

Wilfred Bancroft Sylvester, 116 Church St., Watertown, Mass. 02172, died on July 27, 1967. A native of Reading, Mass., He was associated with us in Course VI for the freshman and sophomore years. He had been an apprentice seaman in the S.N.T.C. at M.I.T. He later earned the A.B. degree at Iowa State University.

Russell Benton Tewksbury, 52 Stoney Ridge Drive, Hillsdale, N.J. 07642, died on July 6, 1970. A native of Winthrop, Mass., he entered in the freshman year and was graduated in Course VII with a certificate in public health. At M.I.T. he was a private in the S.A.T.C. He also earned the doctorate in science at the School of Hygiene of Johns Hopkins. He served variously as statistician in the research department of United Fruit Co., Boston; as assistant manager and assistant traffic manager of the Fruit Dispatch Co. and United Fruit in New York City and New Jersey and had been a biostatistician in the Washington central office of the Veterans' Administration. He is survived by his wife, Dorothy S. Tewksbury.

Arthur Lewis Silver, Beaver Hill Apt. 21-A, Jenkintown, Pa. 19046, died on July 26, 1970. Born in Brookline, Mass., on May 22, 1899, he attended Brookline High School. At the Institute, he was a member of Sigma Alpha Mu, the Mechanical Engineering Society, Corporation XV, the Rifle Club, Musical Clubs and Tech Show. In World War I, he served as post sergeant in the S.A.T.C. at M.I.T. Art was graduated with us in Course XV. He had been associated with the New England Fibre Mills, Boston, and in merchandising management capacities with Sears, Roebuck & Co., Chicago, and the John Shillito Co., Cincinnati. He organized his own insurance consulting and financial planning firm in Glenside, Pa. He was married and had a daughter and two grandchildren.

Ralph Gillett Barrows, Davis Rd., Marblehead, Mass. 01945, died on Nov. 16, 1970. A West Point graduate, he was associated with us in the senior year and received the bachelor's degree in Course I. A veteran of both World Wars and retired colonel, Corps of Engineers, he had been a member of Admiral Nimitz' staff, chief engineer officer of the 10th Army in the invasion of Okinawa and a member of the group that planned the Japanese campaign. His decorations included two Commendation Ribbons and the Legion of Merit. Following retirement, he became head of the wheel department of Blanchard Machine Co., Cambridge. Surviving are his wife, Katherine; two sons, Thomas, M.I.T. '48, and Richard; two daughters, Mrs. John Carter of Marblehead and Mrs. Ross Whittenburg of Concord N.H.; 15 grandchildren and one great-grandson.

One behalf of his many friends in the Class, we extend sympathy to his family and to the Class of '24 on the passing of Henry B. Kane, '24, Director of the Amity Fund for 26 years from its inception to his retirement in 1966.

Join '21 in 'Seventy-one!
This is almost your last opportunity to tell **George Chutter** that you and your wife want reservations for the 50th Reunion jubilee. Better to act now than be sorry later. Whatever your decision, please don't fail to help your secretaries maintain these columns in the manner to which you have become accustomed—by promptly returning that questionnaire form attached to the back of the '21 Class Directory you received. It takes only a minute of your time—and still only a six-cent stamp—to provide the assistance we need so urgently to prepare news of the Class. We've done our best for you and ask so little in return. Won't you do your part? We'll send another sheet if you can't locate yours. Please! Now!—**Carole A. Clarke,** Secretary, 608 Union Lane, Brielle, N.J. 08730; **Edwin T. Steffian,** Assistant Secretary, Steffian, Steffian and Bradley, Inc., 19 Temple Place, Boston, Mass. 02111; **Sumner Hayward,** Assistant Secretary, 224 Richards Road, Ridgewood, N.J. 07450; **George A. Chutter,** 50th Reunion Chairman, Box 305, Boulder Drive, East Dennis, Mass. 02641

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Greetings to Fiftieth-Reunion-Classmates of 1922! Parke Appel and his local helpers are giving much thought to Conveniences, Comforts and Fun for our Reunion in June 1972. As we gather on June 6-7, 1971 suggestions will be in order and most welcome. We are proud to note that the total now reached toward our 50-year gift is $620 thousand with evidence that added larger gifts will establish a new record in the next twelve months.

We are indebted to Phillip T. Coffin '21 of Naples, Fla. for writing about our combined classes in Course VI-A. He advised us of the death last June of **Frank Gage** in Long Beach, Calif., after a prolonged illness. Frank was a grand guy at M.I.T. and we well remember his ability at the piano key board. Phil says he misses Clate Grover and of course the rest of us join him in that thought.

We were delighted to have received the following letter from **Arthur F. Rogers** in January: This being the first letter I have ever written to the '22 Class Secretary, I hardly know where to start. But since I have a purpose in writing now, I might as well start at the end, which is to say that I have finally retired after 28 years at Kennedy Airport. I have been continuously employed there in charge of many of the various phases of construction since we started pumping the first sand fill from Jamaica Bay on May 1, 1942, first for a consulting firm to the City of New York and since 1950 with the Port of New York Authority, which makes me the longest-term employee of the Airport. As I have an aversion to the City, I have not attended many of the functions there. My one constant contact with the alumni has been **Billy Huger,** who used to make frequent trips to New York and often called me up to have a cup of coffee or a late afternoon drink with him before his return flight to Atlanta. I have no retirement plans, but will take life easy here in Great Neck for the rest of the winter, and hope to drive down to Hollywood, Fla. with my wife Helen, to visit my only son and two grandchildren in the spring. We also have several friends and relatives down there whom we hope to see. Best regards to all my friends and former classmates in '22."

Oscar Horovitz wrote from Pompano Beach, Fla. asking to call him only at 8 a.m., 1 p.m. or 6 p.m. as he lives on three golf courses and is practically never in his condominium. We read in the *Boston Globe* that Oscar has just won his 96th and 97th awards in worldwide motion picture competition as a Fellow of the Photographic Society of America.

Crawford H. Greenewalt is chairman of the Organizing Committee of the International Union of Pure and Applied Chemistry for its 23rd International Congress in Boston during July 1971. The scientific program will represent macromolecular chemistry and organic chemistry. The opening ceremonies will be held on Monday July 26 and is open to registrants. . . . Our tennis and sailing enthusiast **John Skelton Williams** is still full of pep staying at his Woods Hole house on Strawberry Hill during July and August. . . . **Randall E. Spalding** and Mrs. Spalding of Whitefield, N.H., have operated the Spalding Inn Club in the White Mountains since 1926. Many M.I.T. alumni, faculty members and families have vacationed there. For many years the Club was the only summer resort advertised in the *Technology Review*. . . . **Harvey Williams,** Course VI, of Philadelphia, although retired since 1966 has continued to give advice and assistance with top management policies, organization and international operations on financing. He therefore keeps comfortably occupied with interesting projects including those in far countries. He is vice chairman of the Board of Trustees of Tabor Academy and has been busy as head of a Committee planning

a new academic complex for completion in 1972 costing $2.5 million. . . . **Paul S. O'Brien** of Baton Rouge, La. has retired from Mobil Chemical Co. He stays very active in the field of alcoholism—its prevention, education and rehabilitation by writing, lecturing and counselling.

The sympathy of our class is extended to the family of **Harris B. McIntyre** of Marblehead, a retired employee of the New England Telephone Co. where he worked as a general rate engineer. He was a life member of the Telephone Pioneers of America and received a 50-year pin from the Philanthropic Lodge of Masons. He was a past president of the Unitarian-Universalist Church. . . . We are also sorry to learn of the death of **Edward A. Larner** of Tremont St., Boston.

Among the changes of address received are those of Dr. Charles G. Moore, Green Valley, Ariz.; Arturo Ponce Canton, Merida, Yucatan, Mexico.

And now your secretary goes to lead a Chamber of Commerce Trade Mission in March to Costa Rica, Guatemala, San Salvador, Yucatan and Mexico City. Please stop in Buffalo to see the astounding pictures which no doubt will result from this trip. Good health to you all!—**Whitworth Ferguson,** Secretary, 333 Ellicott St. Buffalo, N.Y. 14203; **Oscar Horovitz,** Assistant Secretary, 45 Gerard St., Boston, Mass. 02119

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Howard F. Russell, who has agreed to continue as our Class President a little longer in order to give the class time to elect his successor, writes that he and his wife, Mildred, approve **Herb Hayden**'s suggestion that the 50th Reunion be held at the Marriott. Howard and Mildred have requested a room reservation for the reunion. They are tentatively planning to fly into Boston the day before, rent a car and drive out. Howard also thinks that the McCormick might serve as an alternate, in the event that the Class would favor this because it is apparently less expensive. I assume from Howard's letter that Herb has agreed to be the Chairman of our 50th Reunion, and I want to say right here and now that our Class could not find a better man for the job. Through the years, Herb has maintained a keen and active interest in the welfare of 1923, and has, I believe, attended *all* of our reunions. It is hoped that the rest of our classmates will follow Howard's excellent example, and make reunion reservations early. Undoubtedly, reunion details will be sent out in the near future.

Turning now to our Class History, I have received a letter from **Dave Davenport** in which he quotes poignant paragraphs from the stack of letters he is receiving from class members, as follows: "It is nice to think that I may be included in the History of the Class of 1923, many of whose members have had brilliant careers in engineering, chemical, electronic and atomic pursuits, and so have been made bold to list my doings since 1923." . . . "I'm afraid that my biographical sketch will add little to the Great History of the Great Class of 1923, but I thought you might like to make the record complete. Best wishes to you personally and best wishes for great success in the compilation of the History of 1923." . . . "The Great History is really a great idea. My very best congratulations for such a project and my best wishes for its success! I'll be looking forward to many delightful moments while reading our great history. Send it as soon as it's ready!" . . . "Congratulations (and condolences) on having taken on this tough job for your classmates. Kindest regards and best wishes to you, your fine assistant and the other (censored)—Research Editor, Pete Pennypacker." . . . "If there is anything I can do to help you with this History, I shall be happy to have you call on me." . . . From a widow, "This is the best I can do. Had my husband lived, we could have celebrated the Fiftieth Reunion, Class of 1923, also our Fiftieth Wedding Anniversary. I am interested in purchasing a volume of the 1923 Class History."

Earl C. Palmer, In a letter to me dated January 12, stated that he has been retired for over four years with the National Biscuit Company of New York. He was with this company for 32 years. Now he is enjoying a well-deserved retirement, playing golf, swimming and occasionally cutting the lawn. He says "There is nothing like doing nothing." . . . Dave Davenport reports that he is using the talents of **Bob Shaw** as one of his history editors. Bob was president of our class in freshman year and in senior year, and he continued in that office effectively for the first twenty-five years after our graduation. I saw him last at our 25th, and I take this means to say to him that I am glad he has returned from Space and that he is in our orbit once more.

It is hoped that our classmates are not underestimating the comprehensive significance of our prospective Class History. Dave has indicated to me that there are about 1,100 names on our class roll, and that he has information (though not yet complete) concerning 900 of them. It is anticipated that the finished book may run over 700 pages. Dave is pleased with the response he has received, and he wants me to urge all who have not yet replied to his questionnaire to do so without further delay. Remember the old axiom that "the whole is the sum of all the parts" and each man or girl in our class is a part, so we need your record to make the history complete. Send it NOW, if you have not already done so.

The following changes of address have been received: Herman A. Bruson, 98 Ansonia Rd., Woodbridge, Conn.; Stephen B. Metcalfe, 649 Albemarle Dr., Shreveport, La. 71106; Mrs. Eger V. Murphree, 1117 Seaspray Ave., Delray Beach, Fla. 33444; Emil D. Ries, Faulk Manor, 407 Faulk Rd., Wilmington, Del. 19803; Erwin G. Schoeffel, 2830 South Ocean Blvd., Palm Beach, Fla. 33480; Charles F. Woodbury, 700 Mirror Terr. #301, Winter Haven, Fla. 33880; H. H. Zornig, 625 Biltmore Way, Apt. 801, Coral Gables, Fla. 33134.

Complete up-to-date addresses are requested for William E. Dailey, Jr., of Acton, Mass., and for Gabriel Nathan, 11655 Queens Boulevard, Forrest Hills, New York. It is reported that mail has been returned from these men at the above addresses.

Computer Print-out

From a computer print-out, we learn that there are 687 known addresses of living classmates, and we are trying to keep abreast of changes of address in anticipation of our Class History.—**James A. Pennypacker,** Assistant Secretary, Long Hill Road, Essex, Conn. 06426

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I had the rare privilege of seeing on January 28's "Today" TV show, **Luis A. Ferré,** distinguished Governor of Puerto Rico, industrialist, philanthropist and member of the M.I.T. Corporation. He is sure that the progress of living standards in Puerto Rico, which has the highest education budget of any Latin American country, is a splendid example for our Southern neighbors to follow. Typical native entertainment followed with Miguel, a left-handed guitarist, a puppet show and artifacts made by the less fortunate natives for their training, livlihood and fun.

Your scribe is a devotee of *World Press,* the TV capsule of world-wide newspaper thinking, but **Emilio Del Prado,** Professor at Feati University, Manila, Philippines, gives us an "on-the-spot" observation. Unfortunately, this small republic of many islands is having political troubles. All schools, from universities down to grade schools, in Manila were closed in early January for 10 days because of turmoil generated by radical students and a strike by 24,000 Jeepney drivers, protesting gasoline price increases. Further student demonstrations are expected later in January.

Clarence Redden reports his retirement from Scott Paper, but continues active as a pulp mill consultant. His daughter, Martha, M.I.T. '67 S.B. and '68 S.M., married last year and is studying at Cambridge, England for her Ph.D. A bridesmaid was Janet Buerger, daughter of Professor **Martin J. Buerger.** Strange how E.S.P. or Astrology, brings a notice in the same mail that the Professor recently published *Contemporary Crystallography* and on February 1, 1971 received the first Isadore Fankuchen Award of $2,000 presented to "an outstanding teacher-crystallographer for specific work completed within the three-year period prior to the award." The event took place during a meeting of the American Crystallographic Association in Columbia, S.C., when the Professor presented the first Fankuchen Memorial Lecture titled "Crystal

Structure Aspects of Phase Transformation."

Robert W. Barker, who seems to hail from Narberth, Pa., sends us Holiday Greetings, a hope of meeting at the Mexican Fiesta and assurance of doing so in June. . . . **Paul Cardinal,** 50th-Year Reunion Chairman, in spite of fracturing his sternum after slipping on some leaves in a park the night after Thanksgiving (what was he doing there?) sat down long enough to type welcome information to your scribe. He still cannot drive his car, was hit by the flu, had to forget tennis and bowling, gave up I.E.S.C. until April and yearns to visit warmer climes. . . . Latest news indicates that Gladys Hungerford, Helen Wininger and Laura Di Somma are doing very well, the latter now living at 405 Oakwood Dr., Crete, Ill., 60417. Patty Robinson Miller and family receive mail at 955 New England Dr., Westfield, N.J. 07090. . . . Our Florida contingent can hardly boast about warm weather as this is written (2-10-71), but they made their choices and have to take it. Among them: **John Fitch** and Mary at Vero Beach; **Paul Miller** and Helen, Ft. Lauderdale, hoping that some of our more affluent members show up with Cadillacs; **Clint Conway** and Allora computerizing a "go, no-go" Mexican Fiesta.

Hopping back to New York City, we have been wondering whether **Willard Blaisdell** and Hazel were so fortunate as to retrieve any or all of their six-figure purloined coin collection. . . . Syska and Hennessy, Inc., Consulting Engineers, **John Hennessy**'s employer, is greatly concerned about fatal blazes in modern skyscrapers, and by letters circulated among building designers, contractors and operators, has stressed that New York's Building Code and Standards set minimum fire protection and prevention coverage requirements which are generally a broad compromise between complete protection and cost. Your Secretary, as a member of the Brookline, Mass. Board of Appeals, is well aware of building code and zoning deficiencies.

Moving West to California, I have a letter from **Rock Hereford** to Chick Kane which certainly expresses the Class respect and affection for Chick. "I have often wondered if very many ever just sit down and write you a very deep and sincere thank-you for doing your column year after year after year. I am not an expert in judging the relative merits of one Class Secretary over another, but I do know we have been very lucky to have you doing it with such thorough coverage and so thoughtfully worded."

At this writing we are exhilarated by the scientific triumph (laurels to the men of M.I.T.) of Apollo 14 and its astronauts, and we are greatly disturbed by the earth-shaking catastrophe around Los Angeles. The magnitude hit 6.5 on the Richter Scale, versus 8.3 at San Francisco in 1906. Listed in the area are James H. Doolittle, Paul Kusnitz, Alexander Liff, William Mac Callum, T. Thornton Oxnard, Frank Reeves, James Shovlin and Philip Bates. Besides a filial tie in the Boston area, Phil and Jocky couldn't resist several days on Nantucket Island, former blubber depot for the whalers.

Bishop **James C. L. Wong** passed away on April 27, 1970. He was a naval architect and marine engineer, retiring in 1956 as superintendent engineer of Alfred Holt & Co., (Blue Funnel Line), Hong Kong. Consecrated as Assistant Bishop (Episcopalian) of North Borneo in 1960, he rose rapidly in office and was instituted as First Bishop of Taiwan on January 7, 1965. He was awarded an honorary Doctor of Divinity degree by Trinity College, Toronto, and by Virginia Seminary. A graveside service was held on the site of the altar of the proposed Bishop Wong Memorial Chapel, which will stand on a hill overlooking the campus of St. John's and St. Mary's Institute of Technology, Hsin Pu, Taiwan, a school of the Episcopal Church. The Chapel will be a constant reminder of the devoted Christian leadership of our classmate. This information about Jimmie came from Gordon Joyce, a close friend during Course XIII, upon solicitation for the anticipated cost of $57,255.

John H. Walthall writes: "Since retiring, have been mostly cruising in our "Edew II" to Florida, the Bahamas, Chesapeake Bay, St. Lawrence Seaway, Great Lakes, Mississippi and Tennessee Rivers, etc."

Franklin O. Billings: "Still active as consultant on economic development to small publicly-owned electric utility serving a small rural area in NE Washington. Believe that Congressional action will in near future provide instruments for promoting and developing increased industrialization of the nation's rural areas. Would like to correspond with anyone interested in such objective."

Let's close this issue with a footnote. We hear that **G. Fred Ashworth** had a toe removed. This may affect his understanding, but does not clarify ours.—**Russell W. Ambach,** Secretary, 135 Aspinwall Ave., Brookline, Mass. 02146

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The following is gleaned from two communications received about the same time from **Paul P. Wiant,** one via the Alumni Association and the other to me personally. They intrigued me greatly and now seems to be a good time to use them in this column. Paul is hard to classify, he was only at M.I.T. for one year and under very special arrangements, but was arbitrarily classified as '25. He was a graduate of the University of Cincinnati in civil engineering, class of 1914 and he went to China in 1917 as a building man for the Methodist Church. He apparently found that he was limited by lack of knowledge in design and as soon as he was granted a year's furlough he proceeded to M.I.T. and presented his problem to Dean Emerson of the School of Architecture. By special arrangement he was permitted to cram—that is the word for it—all of the essential courses that were possible in a short time. No marks, no credits, the sole purpose to get as much knowledge as he could.

After the year at Tech he returned to work for the Methodist Church in China, Korea, Malaya, Sarawak, Manila, and Hong Kong, also troubleshooting in India, Liberia, and the Belgian Congo. During his years abroad he did over 400 commissions. His last foreign service was as supervisory architect, Tung-hai University in Formosa, with the designing architect, I. M. Pei, '40. Dean Emerson, with whom he had kept in touch, suggested that he join the A.I.A. and not having a formal degree in architecture he was admitted on the basis of exhibits.

During World War II he served in the Marine Corps as a language officer; he speaks Chinese fluently. He saw no active service, but during his previous Chinese experience he had been shot at by bandits many times and had been through numerous bombing raids. He retired in 1956 and apparentiy has kept busy in the intervening years. At the time of these communications he was living with his wife at the Bethesda Retirement Home in Cincinnati. Perhaps Paul is the eldest statesman of our class; are there any other candidates? My impression of the above is that it illustrates what many may have gone through in an active period in the world's history. As we approach our 50th and in my role as Class Historian I would welcome contributions from those that have something interesting and out-of-the-ordinary to relate. I do not promise to use them in this column. I am chiefly interested in obtaining some information for future use.

A communication from Chink Drew, our 50th Reunion Gift Chairman, indicates that he is starting to formulate plans. A rough calculation, no slide rule involved, indicates that the REUNION is now a little over four years away.

F. W. McLaren is now senior partner of McLaren, Kann and Associates, Valuation Consultants, located at 582 Market St., San Francisco, Calif, 94104. . . . **Jim Clifford** is now Professor of English Emeritus at Columbia but still teaching one course and busily engaged in publishing. His latest, *From Puzzles to Portraits, Problems of a Literary Biographer,* University of North Carolina Press. This tells of the adventures of a literary detective. With his many projects he says he does not feel very old. My question: Why? Most of us are just getting our second wind.

John P. Ramsey retired from the New Haven Railroad just before it was absorbed by the Penn Central. He moved to South Carolina two days after his last day at the office, a location which he apparently appreciates, "two inches of snow last year." After what we New Englanders have gone through this past season he is fortunate to be out of Connecticut. . . . **Myron E. Doucette** says that his sphere of daily activity is the

State University of New York at Stony Brook, where he is busy with the Health Science Center under way and some twelve other buildings in various stages of construction, five more large ones on the drawing boards and more to come. He is concerned with the equipment as it proceeds through red tape, policies, and budgetary examinations and expects to be occupied there for a year and a half, "before old age rears its ugly head." He questioned whether my address, Foster St., was named after Doc Foster. Replied with another coincidence: Foster Street starts at Willard Street. Perhaps this is a problem for Jim Clifford our literary detective. See above.

Bernard R. Freudenthal sold his chemical companies three years ago and since has spent much time in Mexico and Europe painting rather seriously. This sounds like fun. When at home he is still interested in consulting for some of his old customers.

Archer M. Nickerson: "I must be considered only a part-time, somewhat semi-retired worker in a small group of friends organized after the closing and sale of the Bethlehem Steel Co. Shipyard in Quincy, Mass. My ratio of work to fun this year ('70) has been 25 per cent. To be truthful it's all pretty enjoyable and I presume most classmates would agree." —**E. Willard** (Will) **Gardiner,** Secretary, 53 Foster St., Cambridge, Mass. 02138

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It's Valentine's Day at Pigeon Cove and for the first weekend in two months the temperature is above freezing. As we start the notes there is not a single craft visible on the ocean in any direction. Only a couple of rugged gulls are patiently waiting on the terrace for their daily handout. The sea is reasonably calm with a rather high pitched undertow wailing from the rocks below. Therefore there is not too much to distract and keep us from getting to the business of writing class notes.

A first in 45 years commands attention. **Smith Davison Turner** has written us! "I spent my whole career, except when on loan to the government in the war, with Standard Oil and affiliates. This was not quite being tied to one desk—I had desks in Texas, London and New York. I practiced my chemical engineering for eight years in Texas, but then began to drift, handling more and more business questions, and ending my career in charge of Jersey's Mid East affairs, more as a negotiator and lawyer than engineer. But always with the log-log at hand. I retired two years early with no definite plans—but I am fairly busy and certainly not bored. I recommend it! I have never been to a reunion, but plan to make the 50th—if I can overcome the idea of being with such an old bunch. 'Sparky' Turner." We replied to "Sparky" suggesting that he change his sights and come to the 45th, for if he waits till the 50th, he will be too old to keep up with us.

Recently "Pink" Salmon sent us a page from *Investment Dealers' Digest* which was an article by our classmate **Cesar Canals** who now carries the title, Executive Director, Puerto Rico Ports Authority. The article tells of the tremendous growth of air and sea transport at Puerto Rico and plans to keep pace with it. A picture of Cesar with the article compares favorably with his picture in *Technique!* . . . A note from **Bob Sherwood** indicates that he also is living in Puerto Rico. He writes, "Enjoying life in San Juan. After retiring in January 1969 from Gulf States Utilities, Beaumont, Texas, planned to come to San Juan for a couple of months—perhaps three—to see our sons. We are still here."

Horace Ruggles indicates that he has made a good comeback after an accident some years ago. He seems to keep busy in various community activities, including the Community Chest Board and the Village Planning Board. He says he travels when the spirit moves him and generally contends that "It's a great life." Horace hopes to be present at the 45th. . . . An address change for **Win Russell** indicates that he is now holed in at East Boothbay, Maine.

A letter from Mrs. Ray Holgate of San Francisco tells us ,"I thought you might want to know that **Ray Holgate** died December 25, 1970 in San Francisco. Ray had been a sales executive until his retirement in 1968 when he became very active in church and civic activities. M.I.T. was always very dear to his heart. Sincerely, Mrs. Marion C. Holgate."

A notice from the Alumni Office tells of the death of **Leslie Currier** on January 3, 1970. For the Class we extend our sympathy to Mrs. Holgate and to the family of Leslie Currier.

The returns are coming in on reunion attendance and most indicate that they plan to attend our 45th on June 4-6. Many who cannot make it have written to explain that they expect to be out of the country. **Jay Goldberg** wrote that his plans called for him to be out of the country but he has changed them and will attend. Since the reunion mailings will be coming more frequently than class notes we will avoid repetition but it looks as though another outstanding class of twenty-six reunion is already assured, and that assurance comes from your attendance. If you are on the fence, let one who has never missed a reunion give you a slight nudge over the fence. It's only a short weekend but the memories will carry on for years (both forward and backward!). Cheerio—**George Warren Smith,** Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

27

It worked! The Class Notes succeeded as a classified advertising medium. Professor Bob Woodbury wanted a 1927 class ring; none could be purchased anywhere, but **Frank Burke** had one he was willing to part with: "I have one I'll gladly let him have—it doesn't fit me anymore." Even Don Severance, who was the middleman in the whole deal, said he "was a bit sceptical about how much luck we would have." The only question now remaining is whether the ring will fit the professor.

Frank Mesker is back home after three spells in the hospital and three operations for cataracts and detached retinas. His eyesight is apparently very much impaired but, hopefully, will improve. We all hope so, Frank. He wrote in his own handwriting, and, incidentally, wanted to know whether I remembered "the lease-breaking party." Can someone fill in the gaps concerning this event?

Howard Ferguson put some of his retirement time to good use by writing the following: "Keeping our New Year's resolution, we must start 1971 by bringing the class secretary up-to-date. After two years of apartment living in Cleveland, which made retirement easy, we decided to try a warmer climate. So in December we moved to this lovely spot in western North Carolina where we found our type apartment. The living room overlooks the fourth hole of the country club—so you can see that I am preparing to defend my championship at our 45th reunion! The 'natives' say January is the worst month of the year—and if they are right, we've made a wise choice. There is a sizeable retirement group in the area, so a number of activities are organized, making it easy to keep busy. Cele and I attended the Chemical Engineering Department's 50th anniversary last fall. We had a couple of fun nights with Polly and **Art Connell.** Connell and Ferguson still follow the practices of 1923-7 and go to bed before 11 p.m.!" Howie also wanted to know how we liked our cargo-liner trip of last year, and I gave it "full marks." His new address is 470 Stepp Ave., Hendersonville, N.C. 28739.

But not everybody is moving south. **Malcolm Graham,** who was in Pompano Beach, Fla., now can be reached at Valley View Court, Norwalk, Conn. . . . **Elwood Church** is regularly oscillating between Seminole, Fla. and Marblehead, Mass. . . . **Charlie Smith** has made good his threat to go to Arizona, specifically at 303D Paseo Cerro in Green Valley. He writes that **Horace Emerson**'s wife has died—news that we are very sorry to receive.

"We finally returned to Toms River (N.J.) last summer" writes **Paul Vaughan** in another interesting letter "after spending a delightful six months in Australia. For an American on a pension, living in Australia is just about ideal. We spent most of our time in Sydney where the climate is perfect, the people wonderfully friendly, and the prices reasonable. The day I left to return the temperature was 65 degrees and this was midwinter! I had several trips to Perth in the mining region, and also to Adelaide

George Chatfield, '28, "anchor man" for the International Rotary Ameteur Radio (ROAR) Network.

and Melbourne. These are delightful cities. I'll not bore you with more details, but the temptation is strong. However, I must say that Sydney has twenty-two beautiful sandy beaches. The scenery is spectacular with high rocky cliffs and sheer drops to the water . . . We were pleased to see **Charles F. Sweet** and his wife here in September. He had recently retired from Ingersoll-Rand, Phillipsburg. He lives in Milford, N.J., and says that this is the third house he has built. Also had a card from **Robert Tucker.** He has retired, lives in New Britain, Conn., and has 'two more grandsons'." . . . At the A.S.M.E. meeting of the diesel and gas engine power division in Dallas last spring, Paul Vaughan was awarded a citation for "material contributions in the design, development and application of diesel engines for railroad service." The original award was made in absentia and the actual presentation was made in New York at the annual meeting in November.

A year or so ago, **Erik Hofman** searched unsuccessfully for a book on the luxury, turn-of-the-century steam yachts. Feeling that a book on this subject would fill a void, he proceeded to write one himself. *The Steam Yachts* was published early this year, and has been very well received. Erik, who is still living in Mallorca, Spain, says that having the book is more fun than writing it. . . . A feature of the M.I.T. Strobe Lab during its independent activities period in January was a concentrated week of effort with strobe photography, especially multiflash photography, by the *Life* magazine photographer, **Gjon Mili.** His early strobe studies of many subjects such as baseball, javelin, tennis, etc., have become the pattern for many to follow. The work in the Lab was, of course, under the watchful eye of **Harold Edgerton,** who literally 'wrote the book' on this subject. . . . **Edward D. Stone** is the architect for two very important buildings now under construction: The John F. Kennedy Center for the Performing Arts, in Washington, D.C., and the Standard Oil Company (Indiana) corporate headquarters in Chicago. . . . **Bob de Luccia,** former senior vice president of Pacific Power and Light, has sent more word on the Oregon Graduate Center, of which he is president: "We accept students who are candidates for Ph.D.'s in physics, chemistry, material sciences and system sciences. We have no undergraduates and no riots!" . . . Want to have a chat with **Lou Eaton?** He is active in ham radio and his call is the same as in 1920—K1BS. This information is furnished by his wife, Margaret. She also confirms that Lou still claims Duxbury, Mass. as home base, although he winters in Florida and summers in New Hampshire. Both Lou and Margaret are in good health. Thanks for this help, Mrs. Eaton.

We are sorry to hear that **Ted Ordman**'s wife is still very ill; Ted is staying with his patent law work. . . . Miss **Sara Scudder** has retired as senior bacteriologist at City Hospital, New York City. She has an interesting hobby of making collages of local, national and international events. . . . After retiring as vice president of Pangborn division of Carborundum Company in 1968, **Art Buckley** has continued as a consultant to Pangborn, substitutes at the local Hagerstown, Md. high school in math and science, and plays a lot of golf. . . . **Leroy Miller** continues to "thoroly enjoy" his retired life. . . . **Fin Dallas Sparre** piled up the admirable total of forty-three years of service with duPont. He retired in April. What a record! He plans to do part-time work with one of the chemical industry trade associations. "I have unloaded four children but still have one third baseman to graduate." . . . **Ted Tedford** insists that nothing startling or new has happened to him but he sends along his best wishes to all. . . . One reason there may not be any 1927 class notes next month is that I may be "away from my typewriter."—**Joseph S. Harris,** Secretary, Box 654 Masons Island, Mystic, Conn.

28

We have had a full and enthusiastic report from **George Chatfield.** You will recall that George was class secretary for many years and he realizes the value of good note material. George has made a career of the advertising business and held responsible positions with prominent agencies over the years (mostly in New York City). Since about 1962 the Chatfields have lived in Lunenburg, Mass., from where George operates a group of businesses including his own radio broadcasting station WFGL 960 Kc, Fitchburg, Mass. George also has his own amateur radio facility, K1UIL, with which he participates as North American Net Control in the European-American International Rotary Club Weekly Network by ROAR (Rotarians of Amateur Radio). Back in 1922, well before entering M.I.T., George was first licensed as an amateur as 9BTL in Minneapolis, Minn. For more recent and current activities, we quote directly from George's letter: "As owner of six small businesses, Station WFGL, Station WFMP-fm (50,000 watts), Music Service Corp. (Muzak franchiser), *Montachusett Review* (2-edition daily with 53,500 circ.), New England School of Broadcasting and Speech Arts, and Creative Services, Inc. (advertising agency), plus distributor and dealerships for Pinkerton Electronic Burgular Alarms, I might say we keep busy even though I acquired my Medicare card May 1, 1970! I plan to keep moving as I love the communications business in this relatively small city area (marketing area 225,000) after 34 years in such highly congested areas as Greater Boston and New York. Here our property (13 acres) is on a nice lake in Lunenburg and only 10 minutes from our broadcasting studios in Fitchburg. My recent activities include: vice president of Fitchburg, Mass. Rotary Club of 180 men, director of Y.M.C.A., director of Junior Achievement, director of two Worcester County Bank offices here and one in Fort Devens. I am also a trustee of the new 2.5 million dollar George R. Wallace, Jr. (M.I.T.) Civic Center and Alice G. Wallace Planetarium. In addition to all this I am U.S. 'anchor man' for International Rotary Amateur Radio Network which gets together every Sunday morning at 1200 GMT (7 AM) on 21.402 Mgc. In the last two summers Marie and I have visited five British and Welsh members of ROAR with whom we talk weekly. Additionally, in September, we attended the Passion Play at Oberammergau in Germany's Bavarian Alps then visited in Zurich, Lucerne, Berne, Lugano, Florence, Paris, Amsterdam, London, Oxford, Cambridge, and Norwich. We had much fun attending Rotary Clubs in most of these places."

A news release of November 18, 1970 announced that **George Palo** is the new

president of Tau Beta Pi Association, national engineering honor society, to serve until 1974. George is retired manager of engineering design and construction for the Tennessee Valley Authority.

We are a bit late with this Christmas letter excerpt from Betty and **Dud Smith** and we must apologize: "The really memorable event for us this past year was a 22-day tour in April to South and East Africa. To get to Johannesburg we had to fly through ten time zones from California. We spent a night in New York at the airport hotel and a night in Paris before taking off on the long night flight from Paris to Jo-burg. We don't go along with the song April in Paris. It may have been pretty with spring bulbs and forsythia in bloom but it was cold and blustery! We walked over to the Eiffel tower from the Paris Hilton but there were long lines of school children waiting to go up the tower so our idea of seeing Paris from the top was quickly given up.

"The weather for the rest of our trip was very good, surprisingly good since we were in East Africa at the time of the 'long rains'. Aside from a very few light showers which helped settle the dust while we were touring in our VW buses, the only rain we had was at the Entebbe airport which delayed our flight to Athens for an hour. We were much impressed with Capetown. Climatically it is very much like Southern California and its location on the Atlantic makes it very attractive. Outside of the U.S. it would be our number one choice of a place to live in. Things from the tour that we remember particularly were the mine dancing in Johannesburg, native tribal dancing done at different mine compounds each Sunday morning primarily for the mine workers; a walk through the rain forest at Victoria Falls where we got drenched in spite of our rented raincoats; our night at Treetops; the sunrise on Mt. Kilimanjaro seen from Amboseli National Park; the trip to the bottom of Ngorongoro Crater to see elephants, lions, gazelles, wildebeest, zebra, rhinos, hippos, etc. and thousands (Dud says millions) of flamingos; the cruise on the Victoria Nile to see hundreds of hippos and crocodiles; and finally the visit to the Acropolis in Athens. We ended the tour with a week's stay in New York and Connecticut visiting friends and Betty's brother and his wife."

A note from **Florence Jope** tells us that she and **Mary Nichols,** with Fran and **Jim Donovan** attended a Waltham (Mass.) Chamber of Commerce dinner January 26 on which occasion Jim was given a plaque in recognition of completion of his services as a director.

Once again we have a most welcome collection of short notes via Alumni Fund envelope news panels. **Howard Emerson** says: "I have retired as head of the Department of Industrial Engineering at the University of Tennessee but continue as Professor of I.E. until June 1972." . . . From **Dick Goble:** "I am now retired and living in Kilmarnock, Va., where I often see our old classmate, **Fred Riley.** We recently had Marty and **Gerry Patrick** down from York, Pa., for a weekend visit. Also recently we were visited by my brother, Pete Goble '25, who is retired and living in Chatham on Cape Cod. . . . From **Samuel W. Marshall, Jr.,** we learn: "I am writing a college text on Environment Pollution Control. Now doing business as S. W. Marshall, Jr., Consulting Engineer. I am still an active licensed commercial pilot, instrument rated." . . . **Hal Porter** writes: "Retired on May 1, 1970 after more than 39 years with the Ann Page Division of Great Atlantic and Pacific Tea Co. Because of previous plans and many interests, I entered the real estate business in the fall. I am now associated with Tilghman and Frost, Wilton, Conn. Son John and daughter Jean each have homes nearby and with two grandchildren all my attachments are right here in the area where we have lived for 30 years."

Mel Sack writes: "After 39 years with the Henry Vogt Machine Co. of Louisville, Ky., I am retiring from my position as General Manager of the Heat Exchanger Division. My new address will be Parker Plaza Apt. 919, 2030 S. Ocean Drive, Hallandale, Fla. 33009." . . . And from **Charles Topping:** "Since retiring from the Development Department of DuPont for the second time in February 1971 I have been Borough Manager of Swarthmore, Pa. and having the time of my life getting things done that have needed doing for many years."

We are very sorry to report that **Robert J. Joyce** died on January 22, 1971 after being ill for a long time. Bob graduated in Course I and had his own business in civil and municipal engineering. He was a member of the St. Louis Engineers Club, Missouri Society of Professional Engineers, National Society of Professional Engineers and the Missouri Athletic Association. He also participated in Alumni Fund work. Besides his wife, Betty, Bob leaves two sons: John Glynn III ('68) and Gerald R.—**Walter J. Smith,** Secretary, 209 Waverly St., Arlington, Mass. 02174

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Having missed our '29 column in the March issue because of lack of news, I appealed to the local V.I.P.s for help. I received several responses. Here is one from Frank Mead: "Enclosed you will find all the news I could gather from the local 29ers." Florence and **Ted Malmstrom** spent the month of December with their two daughters in New Orleans. They have five grandchildren and recently met their first grandson. Florence fell in love with New Orleans and was impressed when she crossed (Attention you engineers!) the world's longest bridge—23½ miles long. They are looking forward to dinner at the Faculty Club in the spring. They reported that Evelyn and **Brigg Allen** have recently bought a permanent home in Orlando, Fla.

The recent cold spell sent Marie and **Jim Fahey** to the Del Ray section of Florida in search of a winter home. Jim will soon retire as president of the Haverhill Gas and Electric Co. Despite the cold, Jim has been doing some fancy skating on the local ponds in Bradford. You won't enjoy that sport in Florida, Jim.

In July, 1971 **Frank Mead** will retire from the New England Tel. & Tel. Co. He and Mary will then move to their summer place in Marion on Buzzards Bay. Frank's many hobbies will keep him going—hunting, fishing, gardening and the latest, golf. Until 1969 Frank always said that golf was an "old man's game," but since then he has joined the enthusiasts and the hole-in-one club. Anyone for lessons? While en route to Fort Myers Beach, Fla., for the month of March, the Meads hope to see the Brigg Allens and the Ed Farmers.

Mary and **Vincent Gardner** of Belmont, Mass., are kept busy trying to keep up with their two sons and their daughter who is at Mt. Ida Junior College. The Gardners are hockey fans and they have had the same seats at the Boston Garden for 25 years. Recently "Vin" who is the administrative engineer at Beth Israel Hospital, was presented with a Twenty Year Service Award.

Joseph Green, of Belmont, Mass., who has been attending our class functions faithfully with his wife Doris, reports as follows: "By staying on at M.I.T. for a master's degree, I found myself in the job market in June 1930. It was a trying and unreal experience by today's standard. The first few years was a struggle for economic survival. Since graduation, I have worked for electric power companies, electrical manufacturing and electronic companies, two years tutoring engineering to M.I.T. and Harvard students, two years as a civil engineer for the U.S. War Department, and five years for Bethlehem Steel Co. The surprising thing is that I have always remained in the engineering field." Joe is presently a supervising engineer at Boston Edison Co. and is due to retire next year. Doris who is a homebody, stayed in Belmont while Joe spent 30 days traveling in Europe and Asia. Joe found that his high school French and German came in handy in several instances. Doris has promised to accompany Joe on his next trip.

I have a report from Joan and **Wally Gale** of Melvin Village, N.H.: "Instead of enjoying the beauty of our New Hampshire fall, Wally and I took a cruise to the South Pacific and New Zealand. We stopped at most of the usual places, Tahiti, Mooreau and Bora Bora. Raratonga in the Cook Islands was a bit different and very friendly because it is not frequently visited. New Zealand is as beautiful as we had expected it to be. We were met at the dock in Auckland by our fishing guide who drove us directly to Lake Taupo, where we had three wonderful days of trout fishing. A high spot of our trip was having luncheon

in Wellington with Sir Arthur Tyndall, '23 and Lady Tyndall. 'Bey' Tyndall is a classmate of John Burchard, who introduced us and they are close friends of the Carl Floes, Penn Brooks and many other M.I.T. people.

"Our most interesting stops were on the return trip. The tiny island of Rapa Hi, a French possession, was very primitive. Its chief distinction is its remoteness, as it was Admiral Byrd's last stop before Antarctica. Then on to Easter Island, where we were fortunate to have a relatively calm day so we could go ashore in tenders. We were driven around the island in native but comfortable trucks, to see the craters and gigantic statues. We arrived home just in time for a snowy Christmas in Melvin Village."

I have an inside tip that the Gales are very fond of fishing and they do so much of it, summer and winter, in their native habitat that the fish see them coming and they don't bite. This trip to the South Pacific was partly an excuse to have a fishing expedition in new far-off regions where the fish don't recognize them.

Herman P. Meissner of Winchester, Mass., was recently promoted to Lamont du Pont Professor of Chemical Engineering and Executive Officer of the Department of Chemical Engineering at M.I.T.

I received a post card from Bangkok, Thailand, from **Hunter Rouse,** of Iowa City, Iowa. He writes: "Dear Karnig: This time I remembered (to send the card). I am here for a month on a UNESCO mission for the upgrading of engineering education in Thailand, with its two universities in Bangkok and three outside. Home, with luck, before Christmas. Don't let the class notes deadline get you down; how about a new questionnaire to those who did not reply? We all appreciate your regular and newsy column."

I have a memo from A. L. Bruneau, Jr., Alumni Day Committee that M.I.T. Homecoming this year is Sunday, June 6, 1971. In regards to "Pops" on Sunday, please note the following: (1) Tickets can be guaranteed only up to May 5. (2) All reservations must be made with cash. (3) Prices of the tickets are: floor and front first balcony, $6.50; rest of first balcony, $4.50; second balcony, $3.00; the rest at $1.00. Send your reservations direct to the Alumni Office.

A brief note comes from **James C. Coe,** Course VI, Phoenix, Ariz., saying that he has published four feature articles in mineralogical publications during 1970.

Jarvis M. Hazard, Bellerose, N.Y., writes, "Retiring from work at Aerospace Division of Universal Oil Products, Melville, N.Y. as of January 1971. I became 65 years old on December 24, 1970."

Best of health to you all.—**Karnig S. Dinjian,** Starlight Towers, Apt. 14E, 6000 N. Ocean Blvd., Fort Lauderdale, Fla. 33308

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This month we have brief notices concerning the retirement of two more of our classmates. One mildly frustrating aspect of these notices is that the retiree is often vague about what he has retired from and sometimes doesn't give any inkling of what he was doing when he retired. However, in at least some cases the records I have accumulated have been of help. . . . As of October 31, 1969, **Ernie Reisner** retired after 27 years of U.S. Government service and says he is enjoying his retirement. According to my records he was chief of the Industrial Support Services Division of the Small Business Administration in Washington. His division was concerned with the evaluation of the qualifications of small firms for handling government contracts. . . . **Bob Asbury** retired on September 1, 1969 as superintendent of administration of the research and development department of Ethyl Corporation in Baton Rouge. He has remained active in church administration and affairs. The Asburys' daughter Carolyn graduated from Louisiana State University, received an M.A. from Northwestern and is now teaching.

Those of you who attended the 40th will recall that the **Fred Dickermans** arrived at the reunion in a large and impressive camper in which they plan to do considerable traveling. A note from **Frank Hankins** says that the Dickermans stayed overnight with the Hankins on the way to the reunion and that they had a pleasant visit. The Hankins' son Timothy is working toward a Ph.D. this spring. He is now doing special work at the Arecibo, Puerto Rico radio-telescope as a basis for his dissertation. . . . **Hank Bates** is corporate vice president of Johns-Manville, in which capacity he assists the president and chief executive officer in administrative matters relating to the business. The Bates' son Roger graduated from Princeton and received a master's degree from Stanford. Daughter Virginia attended Wheaton for two years and graduated from Russell Sage. Hank mentions golf as his hobby, and his performance on the course at Wianno suggests that he may devote considerable time to this activity.

In conclusion I might say that the brevity of the Notes this month evidences the fact that you have been letting me down a bit in the matter of returning the information forms I send out each month; the percentage of returns has been pretty low recently. . . . Changes of address: William F. R. Griffith, Jr., 333 So. Alvernon, Apt. 46, Tucson, Ariz. 85711; Dr. Edward J. Nolan, Palm-Airy Country Club, 3001 South Course Dr., Apt. 102, Pompano Beach, Fla. 33060—**Gordon K. Lister,** Secretary, 530 Fifth Ave., New York, N.Y. 10036

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A most welcome letter has been received from **Gerry A. Benoit** which I am going to quote because I'm sure it will be of interest to a number of other classmates also: "In looking over the February 1971 issue of *Technology Review,* I saw the picture of **John Minami,** his wife and you. It was a very pleasant surprise, although I'm not quite sure about remembering you, I do remember John. We were together at Chauncy Hall in the fall of 1926 and went on to M.I.T. the following year. Two years ago we were in Florida (my wife and I) and we made it a point to see **Jack Wilkinson,** who also was at Chauncy Hall and M.I.T. He has his home in Tavernier, next to Key Largo. We had quite a confab. We took pictures. Jack knew John Minami. **Roger P. Brown** and I came from Southbridge to go to school at Chauncy Hall together. Roger is now running a ball-bearing concern in El Paso, with one of his sons. He has been down there since he has been out of school. We've been in touch with each other. He also knew John. I have often wondered about John, whatever he had been doing, and his health, which you answered. If it were possible to have his address, I'd like to drop him a line. (Note: John's home address is Hakusan Yon-chome 28-8, Bunkyo-ku, Tokyo 112 and his office address is Department of Architecture, Waseda University, Nishi-Okubo, Yon-chome 170, Shinjuku-ku, Tokyo 160). Our home is about 4 miles from Old Sturbridge Village and is the oldest house in Southbridge and has a history . . . I am now semi-retired and enjoying my hilltop home."

Harold J. Davis reports that he retired from Raytheon Co. on December 31. . . . **Lou Evans** says that he is currently running an in-company training program for engineering and scientific personnel throughout Mobil's worldwide manufacturing operations. It's a new venture which Lou undertook six years ago and it is proving eminently successful—and satisfying. These programs, Lou reports, are unique in the industry, and are serving to upgrade the competence of some 200 Mobil personnel per year. . . . **Glenn Goodhand,** who retired as a brigadier general of the army in June 1964, is now employed as Washington representative and assistant to the general manager of the Vertol Division of the Boeing Co. in the manufacture of helicopters and other vertical rising aircraft. . . . Word has been received that **Howard Huntress** is transferring within the Abex Corp. to a new products group still in the research center where he will build computer programmed models for simulation and design. Howard's four children are all through college and have moved away. One of his children is a dentist. . . . **Alex Kuhnel** is now in his 27th year in system engineering for the Austin Co., Cleveland, Ohio. He is a registered professional engineer in New York and New Jersey and a member of N.S.P.E., N.Y.S.S.P.E., O.S.P.E., I.E.E.E. and I.S.A.

George Manter says he keeps fighting for what he thinks is right but the only rewards so far are "financial, meager—frustration, great." . . . **Myrle Perkins**

seems to be enjoying London, where he has been living for 2½ years, working with Bechtel International Limited. He reports that his work involves a pleasant mix of travel and work. (I've talked with Myrle several times in London, but unfortunately, we have never been able to get together.) . . . **Fred Elser** (W6FB) and I (W1ES) continue to keep our Saturday ham radio schedules whenever we can and would like to have any of our other classmates join us. The time is 5 p.m. New York time and the frequency is 21020 KHz. During our last contact, Fred reported that he hadn't suffered any damage in the earthquake but that he could feel it. . . . **Francis W. Truesdell**'s new address is 30 Shangri-La, Largo, Fla. 33540.

It is with regret that I have to report that **Henry R. Westphalinger** passed away on May 19, 1970 and Dr. **Paul H. Doleman** on January 8, 1971.

Latest returns on our 40th reunion attendance look great. Don't forget the date: June 4 to 7. At this writing, I haven't received a report on the January 25th meeting which I couldn't attend because I had to be overseas. However, you'll be brought up to date in the next class notes—**Edwin S. Worden,** Secretary, 35 Minute Man Hill, Westport, Conn. 06880

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Richard E. Evans, who received his Ph.D. in physics at M.I.T. in 1932, has been appointed Associate Professor of Biophysics at Nova University, Ft. Lauderdale, Fla. He will work in cooperation with a team of biochemists, immunologists, and other seasoned experts to create sponsored projects in biophysics. The program plans to study the effects of electrical activity on virus and bacteria and to determine how to inactivate or kill bacteria by electrical phenomena. One practical use of such findings will be in the treatment of sewage. Richard spent 25 years with the Remington Arms Co. in Bridgeport, Conn., where he was responsible for basic research and new product development. He is a consulting physicist and experienced sailor and lives in Ft. Lauderdale. . . . **William I. Stieglitz,** of Stieglitz Associates, Huntington, N.Y., comes to my attention as the reviewer of a new book, *The Search for Air Safety.* He writes an enticing review from his knowledge of the subject.

Carroll L. Wilson, professor of management at M.I.T., has an article worth reading in the January 23, 1971 issue of *Saturday Review,* titled "Environment: Preparing for the Crunch." The article describes the project called the Study of Critical Environmental Problems (SCEP) being sponsored by M.I.T. A detailed report of the project written by Carroll has been published by the M.I.T. Press under the title "Man's Impact on the Global Environment." . . . **Theodore M. Lichtgarn** writes from Palo Alto, Calif., that he retired in January 1970 after having worked as design engineer in several structural design firms. Theodore was a design engineer in various shipyards from 1933 to 1949, and, desiring a change of occupation, entered Stanford University in 1950 and received a master's degree in structural engineering in 1951.

Leo T. Tyburski is now retired from American Chain and Cable Co. and is planning another trip to Europe soon. . . . **Robert S. Prescott** writes that in spite of the slow-down in engineering, he is busier than ever. Both children are grown and married; the oldest is in civil engineering near Rochester and the youngest and wife are in Switzerland.

Benjamin Shreve writes to tell us of his marriage (his first) to Minerva C. Turner on September 12, 1967 in Seabrook, N.H. This makes us all feel happy, Ben. . . . **John Lawrence,** who is board chairman of Dresser Industries, Dallas, Texas, was reelected a director of National Life Insurance Co. of Vermont. John is a native of Rutland, Vt., and maintains a summer home in Charlotte.

We regret to report the deaths of the following classmates: **Perry S. Lobdell** died on December 5, 1970. He resided at 5 Brightside Ave., Kingston, Mass. **Lawrence M. Hubbard** died on December 30, 1970. His home was at 22 Kenwood Rd., Wethersfield, Conn. **Ralph M. Carpenter,** of RFD #2, Lebanon, Conn. died on September 22, 1970.—**Elwood W. Schafer,** Secretary, Room 13-2145, M.I.T., Cambridge, Mass. 02139; **James Harper,** Assistant Secretary, 2700 S. Grant St., Arlington, Va. 22202

33

Top billing for Cal Mohr this time; he is my current favorite as will be noted. Earlier I sent Cal a copy of *The Tech* which featured a photo and story about the most modern gym team at Cambridge. The article made its way from Cal to **Ivan Getting,** then on to **Dave Treadwell,** all three gym enthusiasts and members of the 1933 gym team, and resulted in a bit of news about the Gettings. Ivan and Dot are grandparents "four times over." That lovely daughter of theirs has four children. Ivan Junior, second child, is still single. The youngest, Pete, is married, and this young couple is expecting come spring. Ivan and Dot have a 50-foot sloop, on which they enjoy many a three-day weekend to and from Catalina Island. Need some crew help, Ivan? Naturally we would love more news from you for our 1933 column. Further, Dave Treadwell, you got into this act by accident, but this does not excuse your not writing Ye Scribe.

Cal continues: **Chuck Thumm** seems to be among the missing! Anyone know about him? . . . Cal corrects me on one item. **Win Partridge** has retired from Union Carbide; he never did marry, and he does live in Texas City. Win, could we not have a short story? Many thanks, Cal, for your great volume of information, in many cases badly needed.

Cal enclosed a clipping, dateline Boston, about Dr. **John J. Hanlon,** Assistant Surgeon General of the U.S. Public Health Service. This clip gives us more on pollutants and pollution, elaborating on lung cancer and the many pollutants causing it. We ask Dr. Hanlon to write us with his story. . . . From **John Wiley,** comes a short one on his (annual) seminar on the Institute calendar, "Flight Transportation," a course in Aeronautics and Astronautics. He says, "I try to outline some of the social, political, technical, and economic problems facing the airport operators and the industry in the big cities, and try to point out trends and developments, and their applied solutions." The most fascinating part of this seminar is the question and answer period, and the sharp young folks, says John, really put one to the test. John, I too hope that you may continue for many more years. Sincere thanks, for me and our classmates; we are all fortunate that you are on that tough job. . . . From **J. Dyer Potter, Jr.** comes a quickie. We will recall that Dyer retired from the Connecticut state payroll last year and went to work for the DeLeuw Cathery Co. as an engineer on the New London-Groton Bridge construction, and got no vacation. Now he and Petey are to take a Caribbean cruise this winter, on the German ship *Bremen* and then return to work until the real retirement in January 1972. Now, Dyer, when you read this report, you will have returned from Paraíso and we hope you will send us a report, no? Thanks for thinking of us.

Now comes **Henry Kiley** filling me in on Kiley news, by request, of course. Henry is still at home recuperating from his bout with his bronchial disturbance, but is gradually getting back to normal. His eldest son, Henry Jr. is married, living on the west coast and is a captain pilot for Western Airlines. They have presented the Kileys with one grandchild, a daughter. Kevin, second son, has just been discharged from the navy, as a Lieutenant J. G. and is working for a New Jersey insurance company, in computer work. Daughter Mary (named after her class of 1932 mother) is still unmarried, and is working in New York City as an editorial researcher with one of the Rockefeller projects. Henry closes with the admission that early retirement is a very definite possibility. Thanks, Henry for the news.

Friends of **Ralph Cross,** of Fraser, Mich., will be pleased to know that the Cross Company is going great guns, though they are, as all of us, feeling the pinch of inflation. Ralph, upon receipt of my note, was about to take off for Europe to visit the Cross plants in England and Germany. He and Eloise will be gone almost until this bit appears in print. Ralph added, "I did get Christmas cards from **John Rumsey** and **Bob Way.**" I have been wondering what happened to these fellas. Thanks, Ralph; how about writing

me, after you read this, about your travels?

Thomas K. Fitzpatrick comes through with a soliloquy. Retirement, sezzee, consists of being asked to do things that no one in his right mind would tackle otherwise. But, he says that he is learning how to dodge such tasks and requests. He also says that one must watch out for this retirement business, since he is almost as busy as when he was active in his profession, architecture. Tom is connected with one activity which seems to be very close to his heart: the architectural Review Board of the Historic Savannah Foundation. He is also interested in the study of pollution of the Savannah River. Further, he is a consultant in architecture for the Technical Committee of H.E.W. He will keep busy, no doubt. Keep it up Tommy. Many thanks.

Recently I wrote the **Lou Flanders,** suggesting that Florence drop me a line. She did! However, Lou did get into the act with a postscript. Lou is chief heating engineer for the Factory Mutual Research Corporation; is active on national committees for fire protection of industrial fuels, ovens, furnaces and boilers; and otherwise keeps busy winning golf trophies, is another one of those radio hams, and does some mountain climbing (by car) in Switzerland. (Dick Fossett please copy.) Florence is a professional musician, teaches piano and organ, and is the organist at the First Unitarian Church of Newton. Daughter Nancy is a Cornell grad and is a public relations assistant for the N.Y. State Urban Development Corporation. She is married to Dr. Lester Lockspeiser, a resident physician at the New York Hospital. Lou, III, is a University of Rochester grad, with a M. Ed. at B.U. He is head librarian at Dover-Sherborn High School in Dover, Mass. and is currently attending Simmons, working towards a master's in library science. Lou sends along a pat on the back for the '33 notes. Well I can't say that I do not love to hear the praise, because I do. But also, danged if I write the stuff. Lou continues with "best wishes to that gal of yours (Leona) who keeps you under control, though that must be quite a task." Many thanks, Lou and Florence.

Now for a few return cards: **Russ Eddy** says that he has no news, except for the cold, very snowy winter. He adds that there is no M.I.T. Club in Syracuse, N.Y., and no classmates near Manlius. He has, for some years headed up the SCORE program for the S.B.A. in upstate N.Y. This semester, the S.B.A. in cooperation with the Syracuse Chamber of Commerce, is putting on a continuing education course at Syracuse University where Russ is a visiting lecturer. . . . **Don Fink** is currently working on a sister book to the *Standard Handbook for Electrical Engineers,* called *Standard Handbook for Electronic Engineers* of which Don is editor in chief. Don's elder daughter, Kathy, is a senior at Wellesley; son Steve is a sophomore at Brown;

E. Norris and W. Henderson, Class of '33.

and the youngest, Sue, is in senior high and waiting an acceptance from colleges, preferably Brown or Cornell. Don, it is always nice to hear from one of our irrepressibles. Many sincere thanks.

For me, at least, there is always a "first" lurking in the background. This time, our old friend **Italo (Pat) Amenta** comes through. The Amentas, Mary and Pat, have three daughters, all married: Mrs. Carol Lobb of Chicago who has one daughter; Betsy Piskorski is in Bloomfield, Conn., and has an infant son; and Celeste Lorenz lives in NYC, but does not have children, yet. All three girls are college grads; Celeste has a master's in education. The Amentas toured Italy in 1966, and are about to do a similar trip again. Pat is retired, but can't stand it and says he might go back to work. Golly, I don't like these old ME boys working after 50. Thanks a million Pat, and let's hear from you often.

Morris Guralnick sends word that he has not been arrested or convicted, but is quite busy otherwise, having a contract for converting an old victory ship into a Poseidon Missle tracker. The contract involves a 2-year job of engineering and design. They are also designing a 25,000 DWT tankship which will use gas turbines for propulsion. So with several smaller jobs on the boards, what else can I tell you, says Morris? . . . **Mal Mayer** writes from Monterey of a coming trip to England, Schweiz, Italy, Turkey and Portugal, and he would like some addresses of classmates in those countries! Mal, I could give addresses, but chances are they won't answer the phone; at least they don't answer the mail. . . . A capsule from **Dick Payzant** tells us that he has retired from civil service, and after 34½ years has gone to work. He is assistant project manager of DUSAF, a joint venture in designing and constructing the National Accelerator Lab.

Philip S. Cook has retired from his job with Allied Chemical Corporation, where he was manager of development. He and his good wife have just returned from four months in Europe, mostly in Greece. Thanks, Phil, and let's not be so modest; write a little more often.

From **Thomas C. George** comes a capsule still more brief. It reads, "Lockheed Calif. Co.; Flight Test Dept.; working on L-1011, transport aircraft." As I remember it, Tom is an old Purdue, who took his master's with us.

Again we are saddened by the passing of another classmate, **Carl A. Ekwall,** on June 30, 1970. Carl is survived by his sister to whom we have sent the condolences of the class.

I am assured that the 40th Reunion Fund is going along apace, though I have not heard any figures from **Ellis Littmann.** Ellis has just lost his mother, and he has to have a gall bladder operation very soon. This will involve a rest period after the event, and Ellis plans to spend as much of this time in Arizona as he can. Our best wishes for a speedy recovery, Ellis. We need you.

We have an advance notice of the June Alumni Day events from Armand L. Bruneau, of the Committee. Concerning M.I.T. night at the Pops, the committee wishes to allow a little more time than last year for the advance purchase of tickets. This affair was a complete sellout last year. I have made a digest of the main points of the Bruneau letter and the Alumni Homecoming Day program and have enough copies for any who will write to me for information.

If you wish to attend the Pops Concert, June 6, tickets are $6.50, 4.50, 3.00 and 1.00 depending on where you wish to sit. Address all immediate ticket requests to Armand L. Bruneau, Alumni Day Committee, Alumni Association of M.I.T., E19-437, or to me. I have all the information available at this writing. The complete Alumni Day program will come out later, but haste may be needed on Pops tickets. . . . That's it for April. Best to y'all—**Warren J. Henderson,** Secretary, 1079 Hillsboro Beach, Pompano Beach, Fla. 33062

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In recent notes I mentioned a visit we had from **Ray Jewett.** This brought me the following from **Felix Conti,** who is with the T & B Construction Co. in Somerville: "I read in the last *Review* that Ray Jewett and his wife visited with you. Ray was a member of Course I, as was I. The real reason I am writing is to let you know that I also have a home on the Cape where I spend 75 per cent of my time—in the winter, only on weekends. So I thought we could reverse the procedure and you could come over to see me. I am on Wings Neck, Pocasset and my telephone number is 563-5294. My address there is P.O. Box 1004, Pocasset, Mass. The invitation is also open to any of our classmates who might visit on the Cape this coming year." With the weather here in January what it was, I haven't been lured over to see Felix yet. But it will come later. And of course, any of his friends who come this way should remember his invitation.

Gilbert G. Lorenz, '34.

There was, unfortunately, another, less pleasant, paragraph to his letter. Felix also writes, "It is with a sense of deep sorrow that I enclose a clipping from the obituary page concerning the death of our classmate **Charlie Wright.** It is even more meaningful to me because Charlie and I were classmates in high school as well as at M.I.T." The notice announced the death of Charlie in Longmeadow, Mass., where he was living after his retirement as chief design engineer of the U.S. Naval Shipyard in Boston. He is survived by his mother, a brother, and a sister and I would express our sympathy to them all.

Having mentioned Ray Jewett, I should also add the clipping he sent me from the Phoenixville, Pa., *Daily Republican* about **Proctor Wetherill.** It seems Proctor has been moonlighting from his work at Allied Paint as he won a first prize in the Christmas tree awards at the State Farm Show in Harrisburg. His top honors came in the 3-A class for Norway spruce trees. Since I've never gotten better than a C in raising seedlings, I'm not able to comment on the magnitude of this achievement, but it sounds like Proctor is having fun. How about filling us in—is it a hobby or was this the best of what you were raising for the market?

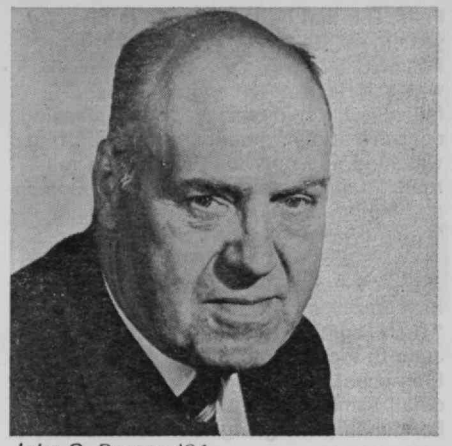
A release from the Army Engineers tells of recognition of a more professional nature that has come to **Gil Lorenz.** Gil, who is the Technical Director of the Army Engineer Topographical Laboratories at Fort Belvoir, has received the Exceptional Civilian Service Medal. This is the Army's highest award to a civilian, and its presentation to Gil marked the first time any employee of the Laboratories ever received such high recognition. The citation which accompanied the medal stated in part: "His extraordinary leadership, judgment, administrative ability, and professional skill were instrumental in effecting a major redirection of programs to take the greatest possible advantage of advances in technology and systems analysis. The replacement of classical techniques and manually operated mapping, surveying and geodetic equipment, at the U.S. Army Topographic Command Production Center and Army field units, by automated systems employing electronics, digital computers and highly accurate optical and mechanical components are the fruition of his efforts. These, and many other outstanding achievements, have contributed significantly to the topographical missions of the U.S. Army Corps of Engineers."

This award came to Gil after more than 30 years of service with the Corps of Engineers. He started at Wright Field in 1936 and served on active Army duty from 1940 to 1946 after which he joined the Engineer Research and Development Laboratories at Ft. Belvoir, where, as apparent from his citation, he has concentrated on topography and geodesy. To put the icing on the cake, in December 1970 Gil received his ninth "Outstanding" rating for his work as Technical Director.

Congratulations are due **Johnny Moomaw** on his promotion to manager of the Control and Planning Division of du Pont's Pigments Department. John joined the Pigment Department in 1934 at their plant in Newark, N.J. He was transferred to Wilmington in 1951 and became a sales analyst in 1952. His work continued in analysis and planning as he became manager of market analysis in 1957, manager of sales administration and planning in 1960, planning manager in 1966, and assistant manager of the Control and Planning Division when it was formed in 1967. That makes a pretty good track record.

Another classmate moving up the ladder is **John G. Borger** who has been named vice president and chief engineer of Pan American Airways. He has been serving as chief engineer since 1963. John had a major part in developing the industry criteria for the Boeing 747. He started with Pan Am in 1935 and over the years he has had a big finger in the pie for his airline in the technical aspects of practically every major transport plane. John has served many years on N.A.S.A. and N.A.C.A. committees, as a Fellow of the American Institute of Aeronautics and Astronautics and lectures at M.I.T. on flight transportation.

Several Alumni Fund returns have come in and this month they each seem to stir me to more than just repetition. From **Sherman Grove,** who (according to the latest Alumni Register) has been professor of engineering at Syracuse University, writes, "I'm about to retire after over 40 years of academic teaching, research and consulting. There must be a better way of earning a living than putting up with militant students and faculty." After reading of some of the happenings at Syracuse in the last two years, Sherman's feelings are understandable. However, it seems sad to be striking such a note in winding up a career which I am sure has brought many satisfactions in the past. However, as an antidote, I suggest Sherm try 30 years of government contract work. . . . I suspect the following may also appear two years down the line in Alice Kimball's notes. From **Virginia Davidson Blakeman,** Course IV (husband, T. Ledyard Blakeman, Course IV-B, '36) comes: "Daughter B. B. (also a city planner) getting married February 13 in Princeton. Three other children and two grandchildren doing well. Virginia is a good impressionist painter. Summers in Cataumet, Mass. (Cape Cod)" I think I've commented before about the apparent affinity between Tech and Simmons, but I'm beginning to realize that Course IV seems to do almost as well on its own. The Blakemans are at least the fourth instance I've seen of "intra-Course" (I hope the printer doesn't slip) marriages. But as I remember it, coeds were in short supply in VI. So we had to look elsewhere.



John G. Borger, '34.

Finally, I see that **Frank** "Choo-Choo" **Moore** is still at his old love—railroads. He writes: "Recent and current jobs I have been working on are: Black Messa and Lake Powell Railroad, 78-mile coal carrier in Arizona; electrification of Reading R.R.—Hatboro, Pa. to Warrington, Pa.; feasibility study of Rapid Transit Line to Dulles Airport." Frank, I've got a proposition for you. You write me the letter you promised at the last reunion about the trip to Africa you were about to take and I'll bring you over and show you the model layout I'm finally getting started on and should have in good shape by the next reunion. —**Robert M. Franklin,** Secretary, Satucket Rd., Brewster, Mass. 02631; **George G. Bull,** Assistant Secretary, 4961 Allan Rd., Washington, D.C. 20016

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We shall start off this month with notes from three of our classmates. **John E. Talbert** writes from Ohio: "I am now a teacher in the Industrial Technology Department of Miami University (Ohio). Not much money, but lots of fun. Some of my students catch on—but others? Wow! Was I that dumb as a freshman at Tech? My wife is a nurse at Kettering Memorial Hospital. My youngest of three children is a 14-year-old girl—I just have to bridge that generation gap. My son is in the Air Force stationed at Guam. My oldest daughter expects to present me with my first grandchild in the spring." . . . **Joseph S. Oldham** writes from Central

Falls, R.I. that he is currently in his 33rd year in civil service, now working as Postal Supervisor. . . . **John C. Alden** writes: "Have now become a grandfather—still enjoy skiing, square dancing, contract bridge, mountain climbing, bird watching and operating HO gauge railroad." John is claim agent for the Boston and Maine, of which John W. Barriger '21 is now president.

Advance notice tells of the M.I.T. Homecoming plans for June 6-7, 1971 with "Tech Night at the Pops" on Sunday, June 6. Please note this is a week earlier than usual. Next month's *Review* will detail some plans that President Bob Forster is putting together for the 35'ers who attend.

Course I classmates will be sorry to learn belatedly of the death of **Gordon Day** almost a year ago—April 24, 1970. He was vice president of McClary Corp. in New York City.

I had a very enjoyable 10-day business trip to California in January during which I was with Verna and **Gerry Rich** in Santa Cruz one day and with Edith and **Ham Dow** in San Jose the next day. We got in two good rounds of golf and I grew fat on Verna's and Edith's breakfasts. I picked the right time to be in Los Angeles and San Diego because they were having an unusual heat wave, while Boston was still freezing.

Announcements will be in the mail shortly calling for entries to the 11th Annual Class Golf Tournament. I hope you who have played in this at any time during the last ten years will try it again in 1971. If you like to play golf, have a club or state handicap, and have never entered this fun affair before, I hope you will write or telephone me for an entry card this year. Please do it now before you forget. And, a happy April to you and yours!—**Allan Q. Mowatt,** Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

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IT'S COMING—OUR 35TH REUNION! ARE YOU PLANNING TO BE THERE? If you haven't yet sent in your reservation for a wonderful weekend at Jug End do so now. . . . **Bill Hope** writes from Durham, N.H. that he is manager for engineering of the Fedder Machinery Division of Moore Business Forms. Two of his three sons are married and he is the grandfather of four. . . . Another grandfather is **Ledyard Blakeman** whose daughter, a city planner, too, will have married by the time these notes are out. His wife Virginia is, in her husband's words, "a good impressionistic painter." The Blakemans summer on Cape Cod at Cataumet. . . . **Ollie Angevine** has had his own firm, Anderson and Angevine, consulting in acoustics for the past six years. He says that he finds it more enjoyable than any other work he has done. His base is Rochester, N.Y. . . . **Bob Gillette** was recently reelected a director of the National Life Insurance Company of Vermont. Bob has been president of Rock of Ages Corp. in Barre since 1954. His daughter Deborah is married to Robert Law of the Class of '54, and is living in Zurich, Switzerland. . . . **Walter Squires** was home over Christmas between assignments in Spain. He can be reached at Apt. 118, P.Q. Esso S.A., Castellon de la Plana. He assures us that the climate is beautiful.

Jack Hamilton reports that his stepson Stephen Raymond received his doctorate in biology at the Institute and is currently a research associate there. . . . **Harry Foster** writes: "I have escaped. If anyone comes through Hawaii look me up. I am fully occupied with golf, hunting, spearfishing and reading all the happy news in the papers." His address is Box 1138, Kamuela, Hawaii 96743. . . . Kay and **Ben Fogler** spent Christmas in Florida and returned to Brazil where they expect to be for the remainder of the year. Ben has been doing an industrial survey of the state of Minas Gerais and they are living in Belo Horizante, some 200 miles north of Rio. The Fogler young are married and scattered from Sacramento to Massachusetts and by now there should be six grandchildren. Their address: Indi/Cemig, Caixa Postale 992, Belo Horizante. . . . When the S.S. *Hope* left Baltimore in January it carried as part of its team of medical volunteers Elizabeth and **Harry Essley.** During the ten months' project Harry will be chief of medical maintenance and his wife will serve as a medical records librarian. Their tour of duty will take place in the West Indies. Our best wishes go with them. . . . **Howard Turner** who received his Ph.D. as a member of the class has been named chairman of the board and chief executive officer of the Turner Construction Company.

Gleanings from year-end newsletters: Ruth and **Henry Lippitt** attended the 11th International Gas Union Congress in Moscow and inspected natural gas installations in the Ukraine. . . . For Winnie and **Pete (F.S.) Peterson** this was the year for several short trips—nothing glamorous. The Peterson sons give them an excuse to travel. Ken, the elder, is a test pilot stationed in Selma, Alabama and David is a sophomore at Penn State majoring in industrial engineering. He has been awarded an Air Force scholarship and will hopefully wind up in Air Force logistics. Pete commented that he hasn't found much news of his close friends in these notes. He wonders whether they are too modest to report. I can't manufacture news and I do try to use every bit I receive so please remember me when you have a moment—**Alice H. Kimball,** Secretary, Apt. 8-6C, 100 Memorial Drive, Cambridge, Mass. 02142 or P.O. Box 31, West Hartland, Conn. 06091

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Class Notes are few for this month. A news release gives us a biographical sketch of Army Lieutenant General **Austin W. Betts** who was highly instrumental in leading the Army through a difficult transitional period in military defense systems. General Betts retired December 31, after 36 years of service, his final assignment as Chief of Research and Development and Nike-X systems manager culminating his years of experience in the field of air defense. On the occasion of his retirement, General Betts was awarded the Distinguished Service Medal—the nation's highest award for merit—by Army Chief of Staff General William C. Westmoreland. Following graduation from Baldwin, N.Y. High School, he was appointed to the United States Military Academy and received his commission in 1934. Initially assigned to a coast artillery unit, General Betts transferred to the Corps of Engineers, with which he has been closely associated ever since. As part of his early training, he received a master of science degree from the Massachusetts Institute of Technology in 1938.

General Betts' long association with airborne defense systems began in World War II when he trained airborne engineers and planned for the construction of B-29 bases in Asia. His initiation into far more sophisticated systems began in 1945 when he was assigned to Los Alamos Scientific Laboratory, N.M., and shortly after became an associate director of the laboratory. From this point on, General Betts' voice and influence was rarely far from the increasingly complex missile defense planning of the postwar decades. In 1957, he was promoted to brigadier general and became director of Defense Research and Engineering, becoming Director of the Advanced Research Projects Agency in December, 1959.

In recognition of his growing knowledge in the rapidly expanding I.C.B.M. field, then-Secretary of Defense Robert McNamara named General Betts Special Assistant to the Chief of Research and Development for the Nike-X Threat Analysis Study. In this post, he headed the team of military and industrial experts who analyzed the various I.C.B.M. threats to the U.S. and possible countermeasures to those threats. For his outstanding work on this study, General Betts was awarded the Legion of Merit. On completion of the study, he was named Deputy Chief of Research and Development for the Army and two years later, in 1966, assumed the position of chief of that department, the position he held until retirement. General Betts is married to the former Edna J. Patterson of Baldwin. They have two sons, Jerry W., who is an army officer now serving in Europe, and Lee W., who is in industry in Orlando, Fla., and a daughter Lynn P., who is a registered nurse.

Thomas F. Griffin, Jr., writes that he is the owner and chief engineer of Thomas Griffin Associates Co., Engineers & Public Works Consultants, located at 562 Congress St., Portland, Maine 04101. . . . **Kenneth M. Gunkel** is cur-

A. W. Betts, '38

W. P. Warner, 39

L. M. Lyons, '39

R. F. Seedlock, '40

rently with Sandwell International, Inc., located at 1618SW 1st Avenue, Portland, Oregon. . . . **Bruce S. Old** writes that he is busy trying to be Foreign Secretary of the National Academy of Engineering and Deputy Foreign Secretary for Engineering of the National Academy of Sciences as well as Senior Vice President of A. D. Little, Inc.—**A. L. Bruneau, Jr.,** Secretary, Hurdman and Cranstoun, Penney & Co., 140 Broadway, New York, N.Y. 10005

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Herman H. Hanson wrote from Sharon, Pa., that he's busy between duties as president of Gilbert's Insurance Agency, treasurer of F. H. Buhl Foundation, director of the McDowell National Bank, and director of the Shenango Inn. . . . From Sacramento, **David N. Lindberg,** with Pacific Tel and Tel, noted that he and Ellen have joined those who rattle about in homes with children having departed for work and college. Dave is becoming involved in the 7th Step Program for ex-convict remotivation, and recommends reading Bill Sands' *My Shadow Ran Fast.*

We have news that **Wallace P. Warner** has advanced to general personnel manager of Dravo Corporation, in Pittsburgh. . . . **Kenneth D. Roberts** after serving for several years as curator of the American Clock & Watch Museum, in Bristol, Conn., was appointed Managing Director in May, 1970. He wrote that they have there the most diversified exhibits of American clocks in this country. With his wife, Ken co-authored "A study of New York Planemakers and Edge Tool Enterprises of the Nineteenth Century" (December 1970) and his own book was published last year: *The Contributions of Joseph Ives to Connecticut Clock Technology, 1810-1862.*

Edward Alvey Wright wrote that he is deputy director of Transportation in charge of planning, design, and construction of all airports, harbors, and principal highways in Hawaii. . . . **Bradley F. Bennett,** formerly consultant to Chief of Naval Operations, now is Vice President for Administration, University Research Association, Washington, D.C., a non-profit corporation of which M.I.T. is a member. U.R.A. is building the National Accelerator Laboratory and its 200-500 GeV proton synchrotron for the AEC. . . . **Harold Chestnut** wrote that he is starting his second year as vice president for technical activities of the I.E.E.E. As such he is on the board of directors and the executive committee, and noted that it has been an interesting experience in view of the changing emphasis of society toward technical matters . . . And while on the subject of the I.E.E.E., **Winthrop Moorhead Leeds** was awarded a gold medal and certificate "for contributions to the development of high voltage circuit breakers, specifically using SF6 gas, and for his effective exposition of the theory of arc interruption." Dr. Leeds retired recently from Westinghouse Electric Corporation, in Pittsburgh with 90 patents to his credit.

As a change of pace to career news, **Irving Peskoe** forwarded several clippings from national newspapers featuring his daughter Anne, who presented a list of Ten Demandments to the principal of her South Dade (Miami) High School. Last May, at a time when the schools were beset with demands from conflicting groups, Anne, with tongue in cheek, made the headlines with ten "demands" prefaced with "I, the Jewish student body at South Dade High School . . . want all classes in Hebrew, Kosher food in the cafeteria, security forces to be headed by Moshe Dayan, compulsory prayer services on Saturday mornings . . ." and so on for her thought-provoking list of ten.

Lawrence M. Lyons, with Burndy Corporation in Norwalk, Conn. since 1940 and steadily rising in the company, was recently made vice president—operations of Burndy's Power Group, with overall responsibility for design, engineering, and manufacture of connectors sold to the electric utility and industrial construction markets.

Here is one belated death notice, as of September 16, 1967: that of **James R. Cruciger,** who was listed in the Alumni Register as with Aramco, Dahran, Saudi Arabia—**Oswald Stewart,** Secretary, 3395 Green Meadow Circle, Bethlehem, Pa. 18017

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For those classmates planning to go to the annual "Tech Night at the Pops," it is on Sunday, June 6, 1971. Tickets can be obtained with a guarantee from the Alumni Day Committee until May 5, 1971. Prices range from $6.50 for the floor and front of first balcony to $4.50 for the balance of first balcony, $3 for second balcony (Rows A-D) and $1.00 for balance of second balcony. Write A. L. Bruneau, Jr., Hurdman and Cranstoun, Penney & Co., 140 Broadway, New York, N.Y. for reservations. The Alumni Day program on Monday, June 7 will be a tribute to Jim Killian, '26. If any of our class planning to attend Alumni Day would like to have dinner together Monday night, drop your secretary a line and he will put you in contact with other members who are interested.

While there are frequent joys in preparing the column, there are some sorrows too. One of the latter is the need to record the death on June 26, 1970 of **Alois V. Menschik,** Course XIII. Alois worked for the Chris Craft Corp. at Pompano Beach, Fla.

Maury Baer in reply to the annual Course V, 1940 Christmas card penned: "Sorry to have missed the last reunion. Had hoped to see you and many others there at that time. Perhaps I'd do better if I moved further away from Cambridge. I suppose a note every 30 years doesn't rank me very high as a pen-pal! My oldest son is now in his 2nd year at M.I.T. and oldest daughter in her first at Kansas City Art Institute. That only leaves two more boys and one girl to leave the nest over the next five years. I've been president of Continental Chemical & Coatings Corp. since 1958 and have found the work to be most stimulating."

Robert Seedlock has recently been named chief engineer—capital improvements for the Port Authority in Pittsburgh. Bob is a retired major general in the Army Corps of Engineers. . . . **Joe Libsch,** Vice President for Research at Lehigh University is included in the first edition of *Engineers of Distinction.* . . . **Bill Singleton** has been elected as an affiliate member of A.I.A. He also is serv-

ing on the Baton Rouge Goals Congress. . . . **Louis Russoniello** recently was appointed to the District Advisory Council, Small Business Administration. After many years running the Garden State Parkway, **Devo Tonti** has departed from public life to go into private industry. Devo received many tributes on his management of the parkway, including the following from the *Courier* of Bayshore News, Inc.: "We were sorry to see D. Louis Tonti resign as executive director of the New Jersey Highway Authority. Mr. Tonti has had a long and successful association with the Authority and we regret that it has come to an end. He is the man who had the intelligence, the foresight, the energy and the guts to get things done. He strived to make the Garden State Parkway a highway second to none in the nation and he did just that. The safety record of the Garden State Parkway speaks for itself, the beauty of the Garden State Parkway speaks for itself and last but not least, the courtesy of the Garden State Parkway employees speaks for itself, and we think all these reflect the leadership of Mr. Tonti. If Mr. Tonti had listened to the politicians the Garden State Parkway would never have been the road it is today, and certainly if he had listened to the politicians on the beautiful Garden State Arts Center we would still have been in the dark ages as far as culture and entertainment it offers is concerned. The energy of Lou Tonti as president of the Bayshore Community Hospital is another story. We are convinced that without this dynamic man and his imagination there might never have been a Bayshore Community Hospital. And just think of the importance of new hospital facilities in our growing area. We say, Lou Tonti, on behalf of a grateful community, thanks for deciding to live in our area, work in our area and get things done in our area."

J. Martin Rosse is a member of the architectural firm of Callister, Payne & Rosse which was given the John L. Merrill design award by the San Francisco Planning and Urban Renewal Association for the restoration and expansion of the First Unitarian Church of San Francisco built in 1887. Not only did it win the *Spur* award, but as reported in the Unitarian-Universalist award, it met the heartful appreciation of the congregation.

From **Ray Keyes** comes his annual Christmas message and letter: "From our winter skies comes the calling of wild geese. They commute in V-formations that undulate like ribbons in a wind. Their flyways are between the Columbia and Yakima Rivers and the wheat fields to our southwest. Their sounds are the music of this season. It makes one think of hunting or traveling. And for us it is a reminder to get the annual Christmas missal underway. Word of this family again goes forth from the bank of the Yakima. Court and Tim worked part of the summer on ranches and Greg worked here fortunately. They all raised steers as 4-H projects for the county fair. Tim's steer was the 4-H Reserve champion. Court achieved fame of sorts as the boy who ripped his pants to shreds in the Calf Scramble at the Fair Rodeo. He did not win the prize but received great acclaim from the crowd for his efforts. Kristin's 4-H projects are more lady-like, sewing and cooking. Her ballet group is presently performing 'The Nutcracker'. Her part is that of a clown and soldier, very appropriate; she likes to tumble. Ray now works for WADCO, a division of Westinghouse, doing the same work at the same place. Virginia keeps the home fires burning, looks to the proper breeding of the cows, and sometimes other chores not customarily performed by women. About those geese that fly over, six did not make it. Our boy hunters got them. Goose meat is on the menu for Christmas. If you are tired of year after year having turkey, do drop by here. We will chew the goose and 'shoot the breeze.' I would like to make a class reunion again, but it will have to be when the young ones have moved on."

Your secretary's firm is moving from its present location after 40 years (the last 17 of which have been the address for this column). Please note this new address effective some time in April.— **Alvin Guttag,** Secretary, Cushman, Darby & Cushman, 1801 K St., N.W., Washington, D.C. 20006

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Joseph O. Fletcher is the author of the eight-page article, "Polar Ice and the Global Climate Machine" featured in the December, 1970 issue of *Science and Public Affairs Bulletin of the Atomic Scientists.* The article traces global climate variations from 4,000 B.C. to the present and includes an analysis of its causes and effects on human activities over this period. Joe is research professor in atmospheric sciences and oceanography at the University of Washington, Seattle.

James G. Terrill, Jr., has been appointed manager of special projects for the environmental systems department of Westinghouse Electric Corporation's Power Systems Company. In this position, Jim will be responsible for developing new product lines and services in the field of environmental protection. The department works primarily with electric utilities to help them identify and develop solutions for environmental problems arising from the generation and transmission of electricity. Jim is a former director of the National Center for Radiological Health and a veteran of 29 years with the Public Health Service. He spent the period from 1951 to 1969 in the development of radiological protection programs for the P.H.S. The programs grew from a concept into the multimillion-dollar national center which he headed from 1966 to 1969. Jim is a member of the National Committee on Radiation Protection and Measurements, the Nuclear Standards Board of the American Standards Association and the Expert Advisory Panel on Radiation of the World Health Organization. A native of Cincinnati, he was graduated in 1937 from the University of Cincinnati with a civil engineering degree. He later did extensive graduate work in public health engineering at M.I.T., and studied nuclear sciences at the U.S. Navy Postgraduate School and the University of California. In 1969, the University of Cincinnati honored him with its distinguished alumni award.

Albert C. Zettlemoyer, Provost and Vice President of Lehigh University, has been listed in the first edition of *Engineers of Distinction,* a new directory of engineers and scientists in related fields, published by the Engineers Joint Council. This first issue of the directory, according to the publisher, E.J.C., is limited to winners of national awards and to officers, directors, and chief staff officers of national engineering societies. Albert's awards include the 1966 Elmer C. Voigt Award from the education council of the Graphic Arts Industry; 1961 Bond Medal from the American Oil Chemists' Society; 1960 Ault Award from the printing ink industry; 1957 Mattiello Medal from the Federation of Paint and Varnish Production Clubs; and 1968 Kendall Award from the American Chemical Society. He is currently co-editor-in-chief of the *Journal of Colloid and Interface Science* and editor of the international journal *Advances in Colloid and Interface Science.* A native of Allentown, Pa., he holds the B.S. and M.S. degrees from Lehigh and the Ph.D. from M.I.T. He is Distinguished Professor of Chemistry at Lehigh.

Howard Samuels is again in the news for his work as head of the New York City Off Track Betting Corporation, commonly called O.T.B. and characterized by Howy as having "the most sophisticated system in the world serving gambling." The system is built around $10 million worth of computer equipment for automating as a way of undercutting the competition among bookies and racketeers. To recover the risk capital going into the system, Howy wants to market O.T.B.'s expertise to other municipalities on a fee basis by providing consulting and management services in the setting up of other off-track betting networks. O.T.B. would even process in its computers bets from such other communities. This would save them the expense of a large data-processing facility, and prevent the formation of a confusing multiplicity of off-track pools. The bettor's contact with the system will be via a window clerk in a branch office, 200 of which will be scattered through the five N.Y.C. boroughs. One of the first to be set up is in Grand Central Station, where 13 New Haven ticket windows are given over to this enterprise. Each office is equipped with computer terminals with cathode-ray tube displays and high-speed ticket printer. The window clerk keys a patron's bet into the computer which thereupon displays the details on the cathode-ray display for verification by the patron. If it is correct the clerk depresses an "accept" key, and the bet is auto-

matically transmitted to the computer processing facility at 1501 Broadway. Simultaneously, the automatic printer issues a ticket that serves as a receipt for redeeming a winning wager. Bets may also be placed by telephone by patrons who have first opened an account with O.T.B. by making a cash deposit because, unlike bookies, O.T.B. cannot extend credit. Each telephone patron is issued a secret code word which must be used in each telephone transaction for identifiction purposes. Howy estimates that operating costs are to consume only 6 cents of each dollar bet, including the payout to the tracks. Another 10 cents will be shared by the city and state government. The remaining 84 cents will be returned to the betting pools for distribution to the winners.

Kenneth A. Roe, president of Burns and Roe, Inc. engineering consultants, has been elected president of the American Society of Mechanical Engineers. Besides his B.S. degree from M.I.T., Kenneth holds a B.A. from Columbia and an M.S. from the University of Pennsylvania. He is a registered professional engineer in 26 states. Two of his four sons are active in the company of which he is president and a third son expects to join the business following completion of naval duty and graduate studies at M.I.T. Other activities include membership in the American Association for Advancement of Science, American Nuclear Society, American Chemical Society, and the National Oceanography Association. He is also chairman of the Industry Advisor's Committee of Manhattan College and of the Atomic Industrial Forum's committee on Nuclear Power and Water Desalting. He now resides in Greenwich, Conn.

David L. Shapiro reports that he has become involved in medical electronic systems and urges those interested in medical electronics to read the article authored by him in the December 1970 issue of *Sperry Rand Engineering Review.* . . . **Erling Hustvedt** reports that his work at the National Bureau of Standards during 1970 included post office automation, F.A.A. economic statistics, new federal agency for technology utilization and H.U.D.'s project breakthrough on factory produced housing.—**Walter J. Kreske,** Secretary, 53 State St., Boston, Mass. 02109; **Everett R. Ackerson,** Assistant Secretary, 831 Cranford Ave., Westfield, N.J.; **Michael Driscoll,** Assistant Secretary, 63 Center St., Nantucket, Mass.

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A note from Dick Feingold, informs us that **Marsh McGuire** has been promoted to vice president of Moore Drop Forging Company in Springfield, Mass. It was recently reported that Marsh left Pratt and Whitney and joined Moore as assistant general manager. . . . **Willis Ware** is listed as a contributor of a chapter in a new book, *Science and Technology in the World of the Future,* published last August by John Wiley & Sons. You'll have to buy the whole book at $11.95 if you want to read Willis' chapter on "The Computer in Your Future."

The American Chemical Society elected **Henry A. Hill** as director from Region I which comprises the northeastern United States. Dr. Hill is president of Riverside Research Laboratories in Haverhill, Mass. . . . **Charlie Smith** was elected vice president of the north central area of the Chamber of Commerce of the United States covering Ohio, Michigan, Indiana, Illinois, Kentucky and Wisconsin.

Miguel Unson writes, "Recently promoted from plant manager, Manila Glass Plant, San Miguel Corporation to vice president, Management Services Division of the company. The San Miguel Corporation is a multi-product company engaged in beer, soft drinks, dairy products, animal feeds, glass containers, cartons, plastics and other packaging products."

Bob Norris writes from Storrs, Conn., that as an Air Corps Meteorology grad with our class, he's been appreciative of our interest. Bob, we're appreciative of your interest too! For the record, he is Dean of Continuing Educational Services at the University of Connecticut and has four children, one just through college, one in college, one entering college and one to go.

On the way down, **John Collins** is looking at the underwater world with tank, fins and mask and has got down as far as 100 feet thus far. . . . **Bob Curtis** (Robert M., not Robert W.—we have two), has left the helicopter industry and has formed Curling Associates dealing in marine electronics with electro-navigational applications and helping to manage small businesses in the Connecticut area. . . . **William C. Fortune**'s last address in my records is quite a mouthful: Chief, N.A.S.A. West Coast New Technology Office, Douglas Space Systems Center, Huntington Beach, California. In any case he sent in a cryptic report as follows, "Still trying to apply advanced technology to solution of problems in the public sector." Sure would like to hear more about that for the next issue.

J. J. Quinn's Golden West Airline is still growing in spite of the problems of trunk carriers. Apparently commuter service is still in good demand. Jack again invites one and all to visit him and to see Golden West's operations at Hangar #1, Los Angeles Airport (LAX).

By June, **Hank Henderson** will be a graduate of Emory University Law School and he says that studying law has been a great experience but a little hard on his good wife, Jean. This, as reported by Hank because he's spent too much time studying and too little time acting collegiate! . . . From **George Watters** in Singapore we hear that he is still responsible for AMOCO's commercial and manufacturing activities in 12 Southeast Asian countries. He's also chief operating officer of a new subsidiary, Singapore Petroleum Company Pte., Ltd. constructing a new $45 million refinery for export of product to all of the countries of the far east.—**Ken Rosett,** Secretary, 191 Albemarle Rd., White Plains N.Y. 10605

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Horrors! Only five notes this month. Let's get in our Alumni Fund contributions because that is how I obtain most of the information.

Andrew R. Buccini has been named division vice president and general manager of the A.M.F. Bakery Machinery Division in Richmond. As general manager, his responsibilities will include bakery engineering, service and installation, marketing and business development (but no cooking?). Andy joined the A.M.F. Bakery Unit in 1950, and became general sales manager in 1965 and marketing vice president in 1967. On the side he is the president of the M.I.T. Club of Virginia and the Executive Club of Richmond. He and his wife Mary have three children.

Mortimer W. Meyer gave us a report in succinct fashion so let me quote: "Honorable Son No. 1, Robert, graduates from Columbia University; Honorable Son No. 2, Joseph, graduates from Columbia High in South Orange; Honorable Son No. 3, David, is a sophomore at Columbia H.S.; Honorable wife, Jean, is very busy at home; Honorable Dog, Frisky, will be 12 years old; and Honorable Servant Morty is Executive Vice President of Anti-Hydro Co." . . . **Arturo M. Morales** dropped a note wanting to hear from members of our class who are interested in coming down to the M.I.T. Fiesta in Mexico City.

Edward P. Radford is Professor of Environmental Medicine at Johns Hopkins School of Hygiene and Public Health. He is in the thick of interesting problems related to environmental concerns which are so much in the news these days. He states that a group of alumni are trying to get the M.I.T. Club active as advisors to the legislature on these problems.

Through the Department of Commerce Fast News we hear that **J. E. Yocom** of the Research Corporation of New England has authored a report for the National Air Pollution Control Administration, "Study of Indoor-Outdoor Air Pollutant Relationships." This two-volume report, issued in May 1970, measures concentrations of particulate matter and some gases and evaluates various building parameters that affect the relationships.

Don't forget the M.I.T. Homecoming. This year Tech Night at the Pops is Sunday June 6. I also received a report on the Annual Class Secretaries' Meeting which was held October 15, 1970. It contained very interesting data on the readership of the *Technology Review.* Those of you who are with companies which may want to advertise in the *Review* should

review the survey results.—**John G. Barmby,** I.I.T. Research Institute, 1825 K St., NW, Washington, D.C., 20006. Give me a call if you are in town.

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For years your secretary has been reading, with envy, about Pigeon Cove as viewed by the eyes and pen of George Smith, Secretary of 1926. The Springers can cause the same concern and envy as I pen these notes Valentine morning, from our new retreat in New Castle, N.H. New Castle, the home of Wentworth-by-the-Sea, is a small island adjoining Portsmouth at the mouth of the Piscataqua River. Mount Agamenticus, the Big A to Maine skiers, looms on the horizon about 20 miles to the east while the Piscataqua runs at our doorsteps. We are still working in Manhattan and New Castle is over five hours away unfortunately.

It is with great remorse that we report the death of Robert B. Hildebrand on Sunday, January 31. Fortunately, Bob had no extended illness and spent most of his last day skiing at Crystal Mountain about one hour away from his home in Seattle. Bob is survived by his wife Virginia nee Ferguson '47, and children Bruce '73, David and Susan. Bob who was Spacecraft Branch Manager, Aerospace Group, spent his entire career at Boeing including a sabbatical as a Sloan Fellow at Stanford. In his own words: "I started out assigned to the task of designing a new 54,000 HP two stage fan for the transonic wind tunnel. Much of my career has been spent in the preliminary design or advanced development of new projects. After my year at Stanford, I worked in our corporate headquarters for two years. Just prior to my present assignment I was Chief Engineer for the Aerospace Group. Our whole family are enthusiastic skiers. In fact, we bought a condominium apartment adjacent to the slopes at Crystal Mountain, Wash. where we have had many fun experiences. Our oldest son, Bruce, is a Junior at M.I.T. Ginny is on the Corporation Visiting Committee on Student Affairs, so we continue to be an M.I.T. family."

Last Thursday's *Wall Street Journal* reported that **David R. Clare,** President of Johnson & Johnson Domestic Operating Co., had been elected a director of the parent, Johnson & Johnson of New Brunswick, N.J. Many of us in the New York area have tried to get together with Dave these past few years but he is always on the go and mostly away from home. . . . Oh yes, **Tom Hewson** is recovering from his detached retina problems if his recent trip to Italy is at all indicative. . . . Rosemary Mumford's visit to the Interchurch Center in Manhattan this past week permits us to update the activities of the **Nick Mumfords.** Nick 3rd '70 and bride, Cathy Bowman formerly of Denver, reside in the Chicago area where Nick enjoys working at Western Electric. Ayliffe is a freshman at a residential college, 1200 students and coed, in Ann Arbor-University of Michigan. Rob, 20, is in the midst of a four-year navy hitch presently stationed in Guam. Elizabeth, a high school senior, looks forward to an exchange year in Finland this summer. I had not realized that Finland had a 13-year basic education system. Nick, as chief engineer, Missile and Space Division of L.T.V. Aerospace, looks forward to new horizons as his LANCE missile system becomes operational.

President **Tom McNamara** indicates that the Honeywell-General Electric computer merger is or has been a traumatic experience! On Friday, December 18, the McNamaras had a mini-reunion with the following Greater Bostonians present: Bill and Elaine Shuman, Gerry and Mary Quinnan, Bob and Ann Maglathlin, Charlie and Nancy Hart, Charlie and Janet Patterson, Jim and Carol Pickel, Dave and Janet Flood, Frank and Dee Gallagher, Dan and Ruth Vershbow and Sam and Geri DiSavino. If Bill Meade had not been on a Caribbean cruise and Dave and Mary Trageser had not had a prior commitment Tom would have had 100 per cent attendance of his 25th Reunion Committee. In a separate note to Fran, Janet Patterson reports that Bob Maglathlin's 25th Reunion slides are excellent—also that it was a snowy trip home to Attleboro that evening!

Ray Grammer's transfer to 45 from 47 became official Christmas Eve. . . . **Hedley Patterson** has completed five years as city engineer in Woonsocket, R.I. Hedley's career has, in many ways, been typical of a restless civil engineer. Short periods of employment with Havens and Emerson in Cleveland and the U.S. Geological Survey in Boston followed by longer associations with Fay, Spofford and Thorndyke in Boston and the M.D.C.'s Construction Division again in Boston; lastly, 10 years with Garlock, Inc. as a sales representative in part of New England. Oh yes, a wife Joan Cargill, plus two children, Mark 16 and Miriam 14. Before marriage much travel such as the British Isles and bicycling the Gaspe and Cape Breton; since then family camping with Yellowstone and Glacier the western terminus.

Would you believe we have a Captain U.S.N.R. in our midst? Yes, and it is none other than San Francisco's own **Vince Butler.** Vince called to report his promotion at 11:50 p.m. Friday, February 5. In a subsequent phone call Vince reported that his kids, Lynn, Diane and Buzzie were more pleased than he, which I doubt! In his bounding way Vince tracked down, after calls to us in New York, Yale University and the University of Pittsburgh, our old Navy Nemesis, F. Curtis Canfield now holding a Chair in Poetry at the University of Pittsburgh. Lieutenant Canfield reminded former Apprentice Seaman Butler that he Butler should have been bilged out 27 years ago. Such is life; I fear Professor Canfield must continue to live with this error in judgment! We were not the only ones to receive this happy announcement, for **Julian Busby** of Okmulgee, Okla. reached us by phone in a neighboring town to report the event.

Thomas J. Martin has just been made chief electrical engineer at Turbo Energy Systems, Inc., Burbank, Calif. Tom and Turbo are engaged in the design, installation and maintenance of on-site generating systems utilizing the total energy principle; i.e. by using the waste heat from the turbine or engine for heating, air conditioning, etc., 65 to 80 per cent of the energy on the fuel is utilized as compared to the normal 22 to 38 per cent. Your secretary together with all others in the New York area would hope that Con Ed might investigate!

Christmas notes from three notables not at our 25th Reunion will bring us up to date. From Edna and **J. J. Strnad** we received an unusual card with European postmarks and photos of mother, dad, Jim, Lyse and Nina taken throughout Europe last summer. We must ask J. J. one question however—why Vassar and not M.I.T.! The following comment came from Lou and **Pete Hickey:** "What a year we've had! Three graduations and a wedding in June. Lisa and Wayne (Van Citters) are in Austin, Texas where she works in the lab at the university and he studies for his doctoral. We never did make it to the Cape this year, first time ever. (Editor's Note—how sinful!) Young Pete is at the University of Miami soaking up some sun and we hope some marine biology; Bill is freezing in northern Wisconsin at Ripon College." . . . From Libby and **Jerry Patterson:** "Busy, busy, busy! We are all well, happy to say. Mark and Rob are home for the holidays; Rob starts college next fall. Liz is becoming a young lady all too quickly. Tony and Mary Lou are living in Dallas and love it; Tony is at S.M.U.'s Law School. Libby and I grow old gracefully!"

George Bickford of Carrier in Syracuse is expanding his E.D.P. activities and is starting a new group to do systems work for Carrier's materials people; wife, Betty, now teaches art full time and still loves it. . . . **Donald J. Lovell** enjoys being back in Boston area as a Professor of Optics at the Mass. College of Optometry. . . . **Ken Deesen** has just finished his 20th year on the teaching staff at Columbia University's School of Dental and Oral Surgery; Ken continues developing techniques and equipment utilizing intra-oral photomagnagraphy for teaching operative dentistry. . . . **William A. Loeb** chairs New York's M.I.T. Center's Public Service Committee; in actuality, Bill operates a volunteer consultant service for Urban Coalition, Interacial Council for Business Opportunity, etc. . . . **Miles A. Libbey** has been appointed director of the Research Center for Library and Information Science, Graduate Library School, Indiana University. . . . On December 1, **H. Jack Leonard** moved to San Paulo, Brazil to be project manager for a $250 million highway project.

As a final note, don't forget to send in your reservations for the Pops concert, Sunday June 6. Tickets will be available until May 5 so make your reservations soon by writing to the Alumni Association, M.I.T. Room E19-437.—**C. H. Springer,** Secretary, c/o M.F.B. Mutual Insurance Company, 420 Lexington Ave., N.Y., N.Y. 10017

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Did you ever have a feeling of dread, knowing that a situation you had hoped would not happen has just happened? This occurred when I sat down to write the class notes for this April issue. There are no letters from the class, no replies to the post cards I have sent out, no clippings or press releases, no notes from a classmate on the alumni contribution envelopes that the Institute sends me. Now comes the realization that I must either pass this issue or write about myself. It is the idea of having to write about myself that is the disturbing thing. I just haven't turned out so well since graduation from M.I.T. in 1946. Not that it has always seemed that way to me, but events of the recent years have produced a re-evaluation of the standards on which one is judged and it now appears I am not shaping up so well.

Everything in my recent life is measured in time from the spring of 1949 when I met a lovely, beautiful girl, Mary Hackett, in Detroit where we used to live. We were married in January, 1950, and during the past 21 years our family has grown to a fine mixture of 10, made up of equal parts of boys and girls. Ages range from 20 years to 5 years with two in college and three in high school. A terrifying aspect of all this is to have five teen-agers all at the same time, but we can survive this. Today the evaluation of a large family is not the same or as accepted as in even recent years, and so now it appears this is one of the areas where I went bad. It used to be that when Mary and I went to a party people we didn't even know would come over and say they wanted to meet the couple that had the eight, nine or ten children. These people had always come from large families themselves, or their parents were part of large families, or they knew large families and they sort of shared a bond with us. Those were the days. We were, well, sort of folk heroes. Mary and I were the Bonnie and Clyde of the nine-passenger station wagon set. Oh, but that is in the past. In these days of attention to zero growth in population the people with the large families are just nowhere, and are not accepted in the old royal manner. When we go to a party now, people don't talk to us so openly. Often your friends slip you a little unsigned hand printed note like this—"How is the family?" "Do Joe and Joan like Ohio State?" "Has Lisa decided between Cornell and Ohio State?" "How did you survive having 5 down with the mumps?" Conversations are something like this, "Hello! No names, please. I wanted you to know I am the 7th of 9, but please don't tell anyone else," or "Russ, I know we have been friends for years and that you saved my life 17 times, but if anyone asks you if you know us please tell them no, as we do not want to become involved." We are suspicious of small groups at parties. Are they talking about us? Are they discussing the preparation of petitions urging opposition to our living in the neighborhood? We search the newspapers diligently to see if a new government agency has been created to deal with the likes of us.

But this isn't the only aspect of life that recently has marked me as a failure. I have been very disturbed by the terrible vocal and written criticisms of this country, its traditions, its system, its people and even its flag. While we certainly are opposed to the terrible war in Viet Nam, we do not wish to shed our heritage and patriotism because of the war which is hopefully coming to an end for this country.

Oh, but the worst is yet to be told. I will creep up on this revelation for you in order to prevent additional suffering. What word has been placed on everyone's tongue and is probably one of the most important considerations before us all? The word is ecology. A word most people could not even spell two years ago and now, fortunately, they all are one. Now where do you suppose I fit into the scheme of ecology? What type of job do you think I have occupied since 1946? The foundry—one of the worst polluters of them all. Now you know everything. Now you know why I was so reluctant to write about myself these past three years. I just have not turned out so well. I am nothing more than a prolific patriotic polluter.

It is now mid-April and our reunion on June 4-7 is not very distant. I am becoming anxious for I remember how great the last two reunions were. This reunion should be even more enjoyable as it is the 25th. Our class contribution to the 25th reunion gift has reached $162,000 of our goal of $400,000 as of February, 1971—**Russ Dostal,** Secretary, 18837 Palm Circle, Cleveland, Ohio 44126

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Our family enjoyed a very pleasant three-day respite skiing in Western N.Y. State for the Washington Birthday weekend. The date may have been wrong, but I for one am certainly in favor of celebrating our holidays on Mondays.

The mail this month is rather sparse so these notes will be in keeping with the short work week. **Kermit Greene** has been appointed general manager of the Sherman Division, St. Regis Paper Co. In this capacity, Kermit will remain in Newton, Mass., but now be responsible for all operations of the division, which has manufacturing in New Jersey, Illinois, and California, as well as Massachusetts. . . . **Bob Horowitz** has been elected to the Board of Governors of the American Jewish Committee. He is living in Boston, where he is engaged in the real estate business, as well as serving as a consultant to many groups concerned with inner-city redevelopment.

John Wittels has been elected president of the M.I.T. Club of Southern California. . . . **Dave Yablong** has been, and is very active in scouting work in Wilmette, Ill., with three sons following his example. His oldest son, Jeff, went to the World Jamboree in 1968 and is now a pre-med student at Brown. Son, Larry, has been chosen to go to the Jamboree in Japan this summer. Dave himself is involved in the construction business around

Chicago as well as in the field of building management. His writing is in my state of the art, which is not the greatest, but on the distaff side of the family, I will venture that wife Joy is teaching in the Chicago public school system, while daughter Judy is investigating schools in the East with M.I.T. a possibility. . . . Drop us a line.—**Dick O'Donnell,** Secretary, 28516 Lincoln Rd., Bay Village, Ohio 44140

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As Secretary of the class that includes the Director of the Alumni Fund, I expected to receive news from the director about the great happenings among class members who are helping him move the Alumni Fund to greater achievements each year. What I expected to happen and what actually happened were quite different. However, this month's mail included a letter from Ken reporting that he was at a cocktail party in Chicago at the Union League Club planned by Dennis Allegretti and Mitch Silverstein. Attending were John Crane, Chuck Licht, Ed Kvatovil, Jerry Krinsky, Harry Meyer, John Nicholson, Ralph Segel, and Cal Alster. Also, invited but unable to attend were many other members of '48 who live in Chicago. Ken reports that with our 25th reunion just over the horizon—who me!—maybe others would like to hold mini-reunions in their cities, to get acquainted before the grand homecoming and just to compare notes with old friends. A note to Ken Brock, c/o Alumni Fund, M.I.T., will bring by return mail, the names and addresses of '48ers in the writer's vicinity. Based on the Chicago gathering, it appears that getting together can be worthwhile and mighty pleasant.

Another opportunity to get together will be at the 1971 Homecoming in June. Tech Night at the "Pops" is Sunday night, June 6, 1971. Before the Pops, there will be an International Buffet on campus at the Student Center. Last year our class had the largest attendance of a non-reunion class, and most class members were seated together at adjacent tables in Symphony Hall. Details of the seating policy have been sent to Sonny Monosson, our Class President, and to me. If you would like to reserve a table, please let us know. Reservations require cash on the barrel head, and must be made prior to May 5. Tickets that are available after May 5 will be sold on a first come—first served basis. This means that after May 5 class seating cannot be assured. The Homecoming Committee is planning to include a tribute to Jim Killian in the program on Monday. Homecoming will give alumni an opportunity to greet Jim at the time of his retirement from the Chairmanship of the M.I.T. Corporation.

I was delighted to receive the following letter from **Louis Kreek** on December 17, 1970: "I have news for you—or rather for the Class Notes in *Technology Review*. After twenty-two years of careful deliberation, I have taken the plunge! On September 12 I was married to the former Miss Gwendolyn Schoepfle. Prior to our marriage, Gwen was a resident of Cincinnati, where she was mathematics department chairman at College Preparatory School. The marriage took place at the United Church of Christ, Kent, Ohio. Gwen's father is chairman of the physics department of Kent State University. Gwen is a Wellesley College classmate and friend of my sister's. Although I have known Gwen since college days, we had not kept touch—I had a prolonged bachelor fling in New Jersey and New York instead—but became reacquainted at my sister's wedding last January, engaged in April, and married in September.

"I am a patent attorney with Esso Research and Engineering Company in Linden, N.J., where I have been for not quite three years. After graduating from M.I.T., I attended George Washington University Law School, where I received the LL.B. degree in 1952. I was an Examiner in the U.S. Patent Office during my law school days, and a patent attorney since then. Gwen and I hope to see you at the 25th anniversary reunion in three years—my first reunion as a married man."

Fred Firestone wrote to report his welcome escape from the smog of the Los Angeles area. He has moved to the Illinois State University as Professor of Economics and Chairman of the Economics Department. "Of course life as an administrator is quite a change of pace; it's the first 9 to 5 job I've had since receiving my Ph.D. from Wisconsin in 1958. But it's agreeable work." Fred's last four years were spent teaching at the Claremont Colleges. . . . **E. William Cummings** wrote a while ago about his appointment as plant manager, Plant 5, Saginaw Steering Gear Division of General Motors. Bill lives in Saginaw, Mich. **Walter L. Koltun** was appointed assistant director for resources of the Harvard-M.I.T. Program in Health Sciences and Technology beginning August 15, 1970. Walter has been in the administration at M.I.T. for a number of years.

Last October, several classmates received Certificates of Appreciation from the Alumni Fund for their efforts on behalf of M.I.T. in the 1970 Fund year. **Denny McNear** in San Francisco, **A. Graham Sterling** in Dallas, **Edward R. Allen, Jr.,** in Houston, and **Joseph Sheredy** in Santa Clara County were the recipients of the certificates.

Nick DeWolf who has been winning prizes as a pictorial photographer had an exhibit of over 150 photographs at the Charles Street Meeting House Gallery in January. "People, Beautiful People" was the title of his exhibit. The show was Nick's first public one-man show and indicates a new style which started with a light-hearted approach to the present youth movement and expanded to a wide range of very human situations. Almost exclusively 35mm work, the photographs were selected from over 20,000 negatives. Each print involves over a dozen chemical steps and are painstakingly finished in a wide variety of techniques. Nick heads up an electronics company which he founded ten years ago. . . . **Jim Irwin** has completed a very interesting three years of technical assignments with Union Carbide, Belgium. He was recently appointed technology manager with engineering and development responsibilities in Antwerp and Geneva. The stay in Europe has been a wonderful experience for the family . . . . **Jim Nagel** has joined Converse Rubber Company as staff industrial engineer.

Incoming mail from classmates is more frequent in 1970-1971 than in past years. I assume some change in the economic climate or in the strength of the earth's magnetic might conceivably be related to the increased mail, but whatever the reason, thank you.—**S. Martin Billett,** Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

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I am having to go to press early this month in order to escape to the Caribbean for what feels like a well deserved vacation. The most recent news will therefore go over until next month.

Robert Kraeuter reports on his Alumni Fund envelope: "Still with the Port of New York Authority in New York City

(9 years). Developing an in-house maintenance program for their extensive electronics systems. The computers are still more economically maintained by service contract, though." . . . **A. W. Bigus** sends us a postcard as follows: "Received a card from Embajada de Honduras, Washington, D.C., from El Embajador de Honduras y la Señora de Galvez." I wonder how **Bob Galvez** and his wife compare Washington, D.C. with Tegucigalpa, Honduras, particularly at this time of year. Clearly Roberto is yet another of our classmates of significance and importance.

So, also, is **George P. Shultz,** who is now the Chief Budget and Management Officer in the White House who, according to an article by William J. Eaton of the *Chicago Daily News,* "seems to be emerging as President Nixon's most influential adviser on economic policy." George, a former economist from the University of Chicago, was named as Labor Secretary in 1969. His performance in that job—and the trust he earned from labor leaders and conservatives alike—seemed to impress the Chief Executive. In the first major shakeup of the White House staff, George was selected to be director of the budget office. He accepted the post even though it meant a cut in pay from $60,000 to $42,000 a year. Since moving to the White House six months ago, George has taken over as chairman of the morning meetings of top staff advisors that once were conducted by John Ehrlichmann. The article notes that in several recent situations where George has differed with Federal Reserve Chairman Arthur M. Burns, the President has tended to come down on George's side of the argument. I imagine we all hope that the current set of economic policies will in fact lead to an upturn in the economy as quickly as possible.

The Alumni Day committee announces the program for the M.I.T. Homecoming Weekend this year, including Tech Night at the Pops on Sunday, June 6, following an International Buffet, and (if the Class of 1949's plans materialize) our Class Cocktail Party. If you live nearby or want to visit Boston early in June, when the weather is usually beautiful, why not make up a party and take advantage of the opportunity to renew acquaintance with the Institute and with your classmates.

I will be basking in the Caribbean sunshine when Ira Dyer holds the next meeting of the **Class of 1949 25th** Anniversary Fund Committee. However, I have asked him to submit a report directly, to be incorporated in this column.

The 25th Reunion Gift Committee met on February 15 and confirmed that we are going to have a gift to be presented to M.I.T. at our 25th Reunion, of a visiting professorship. We tried to think of the many usual gifts that had been made in the past but none of these seemed up to the standards of the Class of '49. Therefore we decided to do something that none of the other classes did and give M.I.T. an opportunity for the infusion of new ideas; the best way to do this was through a visiting professor. Our goal in money is $500,000. You will receive much more information regarding this in the immediate future. Best wishes to all.—**Frank T. Hulswit,** Secretary, 77 Temple Road, Concord, Mass. 01742

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Donald A. Harnsberger is still living in Germany as managing director of Cooper-Vulkan Kompressoren Gmbtl. and Gascomij N.V., supplying gas turbine compressor units for the Western Europe natural gas transmission network. . . . **Ralph A. Horne** is presently a chemical oceanographer at Woods Hole Oceanographic Institution. His first book *Marine Chemistry,* Wiley-Interscience, 1969 was published last year. Numbers two and three are in the works. . . . **John F. McCarthy, Jr.** will join the faculty as Professor in Course XVI in the fall of 1971. . . . **Raymond N. Blair** has coauthored a book with Professor C. Wilson Whitson (University of Southern California) titled, *Elements of Industrial Systems Engineering.* It will be published by Prentice-Hall in February. He is presently the senior editor of *Printing Management,* a national magazine for printing industry executives.

Paul A. F. Mourier-Peterson is in charge of Latin American region for Durr-Oliver, Inc., with headquarters in Sao Paulo, Brazil. . . . **Jon L. Ganger** was elected vice president of Boit Dalton and Church, Inc., 89 Broad Street, Boston, Mass., International Insurance Brokers. Jon has lived in Lexington, Mass. for the past 17 years with his wife, Jewell (Ward) Lasell '49, and son, Ward. . . . **Nate Cook** reports that he and his family have moved from the serenity of Concord to the turbulence of Cambridge. They are now living in the new M.I.T. dormitory, MacGregor House, as housemaster and family. MacGregor houses 324 undergraduate men, 9 graduate tutors and 2 faculty families—so they are never lonely! . . . **Donald W. Ramsey** was appointed Town Justice in the town of Chili in June of 1970. He also won election as Republican-Conservative for three years in November of 1970. Mr. Ramsey is continuing his regular position as project engineer on carburetor test and development, Rochester Products Division, General Motors Corp.

As of January 1, 1971, **Melvin J. Gardner** was elected first vice president and voting stockholder of Shearson, Hammill and Company, Inc. They are located on Wall Street in New York City. Melvin handles investment banking matters in the corporate finance department and is director of new business development.

Andrew T. Ling has been appointed director of the Advanced Development Department at Xerox Data Systems, Xerox Corporation's computer subsidiary. He will direct the activities of the X.D.S. technological planning unit which is responsible for the creation, analysis and development of advanced computer products. Mr. Ling has held several managerial positions in design and development at X.D.S. since joining the company in 1966. He was previously employed by R.C.A. Mr. Ling lives on the Palos Verdes Peninsula with his wife, Fushi, and their two children, Leona and Vandever.

Robert L. Plouffe has joined Computer Sciences Corporation as a senior member of the executive staff in the Systems Division of that company, based at Falls Church, Va. Mr. Plouffe will assist the president of the Systems Division in a wide range of technical and management areas of the organization, the company's largest operating unit. He served for a number of years as a laboratory director in the International Telephone and Telegraph organization, and more recently as vice president and director of engineering at Stelma, Inc., now a division of Data Products. . . . **Walter L. Hill** of Lincoln, Mass., will become vice rector of St. Paul's School in Concord, N.H. Mr. Hill has been principal in the firm of Hill and Associates of Cambridge, Mass., a lecturer on education and urban planning at the Harvard Graduate School of Education, and also the principal in the firm of Hill, Miller, Friedlaender, and Hollander, Inc. He is married to the former Patricia R. Cautley, and has two children.—**John T. McKenna, Jr.,** Secretary, 2 Francis Kelly Rd., Bedford, Mass. 01730

Margaret Irby Koenig, '51, Red Cross Volunteer at the 44th Surgical Hospital in Korea.

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Richard Alden is with the United Aircraft Co. in the Technology Center Division in Sunnyvale, Calif. He and wife Doris have three children, Juliet 11, Lauraine 7 and Mark 5. Richard is presently working for a master's degree at U.S.C.

F. George Arey, Jr. is an electrical engineer with Stone and Webster Engineering Corp. of Boston. He is very active in sports: president of the Byfield (Mass.) Jr. Hockey Association, president of Byfield Jr. Tennis Association and Director of the Old Town Country Club. He and his wife, the former Deborah Doggett, have three children, Dayton 14, F. George 3rd 12 and Deborah 10. . . . Lois and **Curtis Barker** reside in Chevy Chase, Md., with Kathy 15 and Rusty 14. Curt is the University Relations Officer for the Agency for International Development (AID) in Washington, D.C.

John Bergmann is vice president and technical director for N.F.C. Industries Inc. of Mt. Vernon, N.Y. John's work is building breweries and he particularly enjoys the free samples. He and Heidi have two children: Peter 12 and Karen 9.

David A. Bossen quit his job in February 1967 after a disagreement with his boss. He moved from Ohio to California, tried unsuccessfully to buy a business and started his own, Measurex Corp. He is now one of his former employers' stiffest competitors. His is the success story we all dream of and we wish him lots of luck for the future. . . . **Averil B. Chatfield** is with Geodynamics Corp. in Santa Barbara, Calif. He and Trudy have two children, Betty 24 and Janice 13. . . . **John Conley** lives in Olympia Fields, Ill. He is a vice president of Amforge Inc. in Chicago. He was a candidate for the school board in a recent election. Hope you made it, John. . . . **Jerome Elkind** was appointed a visiting professor in the Sloan School of Management at M.I.T. for the 1970-71 season. . . . **Harold Glenzel** lives in Cape Elizabeth, Maine with wife Lois and children: Karen 16 and Steven 13. He was the district plant manager for N.E. Tel and Tel, but has been promoted to General Engineer—Buildings, New England Telephone. This means moving back to the Boston area, namely Hingham, to assume his new duties. Harold graduated from Somerville High School in 1945 and has finally come home. . . . Here's the answer: Margaret and **Ed Handy** have recently moved to 18 Bellevue St., Cambridge, Mass., where Ed is the director of the Community Development Program for the City of Cambridge. We're now up to date (see last month's notes).

Margaret Irby Koenig is doing volunteer work with the Red Cross at the 44th Surgical Hospital in Korea. She has been a volunteer for four years. Her husband Richard is commanding officer of the USASA Group in Korea. . . . **Loring O. Lee** is data processing manager for G.S.I. Ltd. in Croydon, Surrey, England. He manages the largest single group in the exploration seismic industry running four special purpose seismic computers and supervising 100 trained geologists and geophysicists. . . . **Tom McLaughlin** is technical sales representative and consultant for the du Pont Co. in Chestnut Run, Wilmington, Del. Tom and wife Geraldine live in Wilmington with a mischievous 9-month-old collie dog.

Barbara Ann and **Kendall Peterson** moved last summer from Washington, D.C. (where he worked for the ESSA) to Livermore, Calif. His new job is meteorologist at the Lawrence Radiation Laboratory for the University of Calif. They have three children David 11, Chris 8, and Karen 6. . . . Janet and **Albert Rooks** live in Seattle, Wash. with three children, Jeanne 17, Alison 14, and Albert 11. Al is vice president and general manager of United Control, a company making flight controls and instruments.

Joseph Sherrill, Jr. writes from Wichita Falls, Texas that he still practices corporate, tax, oil and gas law. His duties require substantial traveling and in the last year he made several trips to Europe and one interesting trip to the Middle East. He and wife Nancy came to New England in October to visit and interview prep schools for son Joe 3rd, 13. They also have two other children Faith 10 and Lucy 9. . . . **A. N. Tschaeche** is presently the licensing administrator for the General Electric Co. Nuclear Energy Division in San Jose, Calif. He has three children Ray, 13, Joan 11, and Patrick 6 and is divorced. He has a little brother in the Big Brother program and keeps busy sailing, camping, public speaking, politicking, taking photographs and dabbling with electronics.

This month it's Walt Davis carefully suggesting to you that if you haven't made your plans to attend your 20th reunion at Provincetown, get on the stick because we're filling up fast. Any questions, call or send them to us, your class secretaries, or Jay Rosenfield, M.I.T. Class of 1951, 20th Reunion Chairman, 3 Bartlett Street, Marblehead, Mass.—**Walter O. Davis,** Assistant Secretary, 346 Forest Ave., Brockton, Mass. 02402; **Howard I. Levingston,** Secretary, 358 Emerson Road, Lexington, Mass. 02173; **Paul Smith,** Assistant Secretary, 11 Old Farm Road, North Caldwell, N.J. 07006, and **Marshall Alper,** Assistant Secretary, 1130 Coronet Ave., Pasadena, Calif. 91107

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Did you receive a telephone call? Our Class President, Bob Warshawer and Dean Jacoby, Chuck Masison and Roy Kaplow engaged in a recent nationwide telethon on behalf of the Alumni Fund. Even if you were not called at this time, spare us another call and remember to send your remittance to the Alumni Fund in one of the envelopes you regularly receive.

Career Capsule news from the wire services: **John Zubaly 3rd** is presently a structural engineer with the Sun Shipbuilding and Dry Dock Company division of Sun Oil Company. . . . **Paul Koppel** is a chemical engineer, specializing in distillation with International Flavor and Fragrances. . . . **Dave Bourne** has been with the Electric Boat Company for the last fifteen years. . . . **Bill Rawlings,** with Pratt and Whitney since graduation, is a mechanical engineer specializing in jet engines. . . . **Martin Mills,** a mechanical engineer with the Lummus Corp., is engaged in computer application to chemical plant design. . . . **Edward Brandt** is doing financial analysis for I.B.M.

Our Class has its first college president: **John McNary.** Following his bachelor's degree in chemistry, John received his master's degree at the University of Wisconsin and his Ph.D. from the University of Illinois. After stints at the University of Pittsburgh, and again at Wisconsin, he was invited to join the Institute de Biologie Moleculaire de la Faculte des Sciences de Paris, and taught at the American College in Paris. When that school was engulfed in the worldwide wave of campus dissent, he served as mediator, after which he was elected president in 1969.

Morty Davis lives in Manhattan with his family, three children. He is vice president of Dayton Metal Products, a firm supplying fabricated steel to the construction industry. . . . Monsanto has transferred to St. Louis **Bob Lait,** who is now a product supervisor in the Hydrocarbons and Polymer Division Marketing Dept. . . . **Bruce Backe** is president of Imlac Corp. of Waltham, Mass.

Peter Butt, after graduation, returned to Trinidad, West Indies (his home) where he worked in development and construction with Shell. He left there and spent several years in the Philippines in mining with Benguet Consolidated—then back to Trinidad with Texaco working on refineries for a couple of years. He finally returned to the Philippines (his wife's home), where since 1961 he has been president and chief executive officer of Manila Cordage Company. . . . Also from the Far East, **John Goncz** is reported to have immigrated to Australia, where he and his wife Pat enjoy the outdoor life.

In the academic world, **Sewell P. Champe** is Professor of Microbiology at Rutgers University and **John Griffiths** is teaching electrical engineering at the Air Force Academy. . . . If you happen to be travelling in and around Maine and your boat develops a leak, you might contact **Joel White,** who runs a boat yard in Brooklin, Maine; or if you are thinking of an early retirement in your dream house or dream career in Florida, see **Jim Athan,** our architect in Tampa. With these pleasant thoughts, your secretary and his wife Arline leave for a vacation in Bermuda.—**Harvey Steinberg,** 273 Singletary Lane, Framingham Centre, Mass. 01701

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Now that April is upon us, we can look forward to cleaning up the yard and propping up the house. It's a contest between the wind blowing it over and the rain sogging it to death, but with luck it'll last till June. There are other signs of the passage of time, and one of these is contained in a short note from **Wayne C. McClung.** On October 6 of last year Wayne became a grandfather, and he wonders how many other grandparents there are in our class. If you qualify, please drop me a note. Wayne also would like to know of any radio hams in the class. His call is W41YD.

Robert G. Dettmer has been named president of the George J. Meyer Mfg. Division of A-T-O, Inc., a firm that supplies packaging and bottling equipment to the beverage industry. Previously he was president of A-T-O's Scott Aviation Division in Buffalo, N.Y. . . . Among others who have changed jobs is **Alan R. Glueck,** who now heads Chemical Technology Consultants. He reports business is brisk, with projects ranging from simulation of blood sugar balance to an M.I.S. system for a fine arts gallery.

John W. Blake is now technical director—ecology for Raytheon's Environmental Systems Center. He directs a group of fifty biologists, chemists, hydrographers and engineers studying means to minimize the harmful impacts of industrial plants, especially nuclear or fossil fuel power stations, on the ecology.

From Korea, a note from **Doo Har Park** reports that he has been providing engineering consulting services connected with chemical process plants. His firm, formed in 1962, is headquartered in Seoul. He has also been very active as a technical advisor to the Korean government.

I would appreciate receiving more news from class members. Write if the freeway fell on your cat, or if the commune broke up, or even if you were nominated to the arbitration board of the local little league team.—**Allan C. Schell,** Secretary, 19 Wedgemere Ave., Winchester, Mass. 01890

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By this time everyone has received two mailings on the reunion—in response to which each has made his reservation, paid class dues, answered the questionnaire. However, just in case you haven't—contact Bill Grinker at Boston Computer Group, 15 School St., Boston 02108. See you at the Harbor View, the Vineyard, June 4-6.

Hugh Bradley is manager of Scientific Management Services at Upjohn in Kalamazoo. . . . Cornell University has begun a study on national energy needs, the purpose of which is to figure out how to minimize ecological effects. **Bing Cady** as Associate Professor of Applied Physics is one of the interdisciplinary group. . . . In January **Chuck Dietrich** was the featured speaker at the Harvard Business School Club of Boston. Chuck is head of Traffic Sciences Activity at Bolt Beranek and Newman in Cambridge and spoke on auto travel in the 1970s.

Bill Leitch has become a vice president of International Data Corp. of Newton, Mass. He will head the publication "EDP Industry Report" as well as a host of other activities. . . . **Paul Lempel** became a member of the law firm of Kenyon and Kenyon, Reilly, Carr and Chapin in New York in January. Paul has been specializing in patent law since 1964. . . . **John Patierno** is manager, Advanced Aerodynamics and Propulsion in Northrop Aircraft. Also member of the Technical Committee on Aircraft design of A.I.A.A.

Dave Quigley writes that he is practicing orthopedic surgery in Providence, is on the staff of Rhode Island Hospital and Pawtucket Memorial Hospital and Brown University medical staff. Dave and Eileen have four children. More news on **Norman Siegler:** appointment as controller of Ideal Toy Corp. He had spent nine years at Xerox in similar work. Norm and Marlene with their four children are moving to New York City—guess who are most enthusiastic! . . . **Sven Vaule**'s consulting firm was featured in an article in the *Boston Globe* last October 13. . . . **Jerome Vielehr** has moved from Atlanta to Milwaukee and from the New Enterprise Division of Coca Cola to

financial vice president of Aqua-Chem, a subsidiary.—Cosecretaries: **Bruce B. Bredehoft,** 3 Knollwood Dr., Dover, Mass. 02030; **T. Guy Spencer, Jr.,** 73 Church St., Weston, Mass. 02193

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Allen Burgess advises us he is working for CCD-Honeywell in Natick as chief engineer of communication products. He adds: "I now have my flight instructor's license. My best flight this year was to the Fall Joint Computer Conference in Houston, Texas, in a Piper Cherokee Six." . . . **Dominick Fortunato** writes that he has been employed at Burns and Roe, Inc., in Oradell, N.J., as a metallurgical engineer in the quality assurance department. He is assigned to the Forked River Nuclear Power Plant Project (Jersey Central Power and Light) and works on materials selection, welding requirements and quality assurance for plant components (other than the reactor). In addition Dominick is attending classes at N.Y.U. and also taking special courses on non-destructive testing, for example, at Kodak's School of Industrial Radiography.

Leonard Glaeser is the co-inventor of a machine that can read and sort as many as 30 documents per second. The information read is transmitted directly to a computer for processing. Leonard is director of engineering at Control Data's Rabinow Advance Development Laboratory in Rockville, Md. . . . **Dick Mortensen** advises that he has received tenure at U.C.L.A., where he is an associate professor of system science. His research interest is the application of system theory to bio-feedback condition. "Getting high electronically on my own alpha brain waves," he writes, "is my present hobby." (Sounds more like a "current" hobby!) . . . **Albert Gollnick** left the Institute early last year where he had been a research engineer at the Aerophysics Lab. He joined Worthington Compressor and Engine International in Buffalo as a development engineer in their Centrifugal Engineering Department.

Louis Becker sent us the following biographical sketch: "I married the former Loretta Ellen Silverman in May of 1966. We have two little boys and are expecting another child soon. I received my M.A. in mathematics and M.S. in physics from Los Angeles State College. This year I hope to finish my Ph.D. in physics (general relativity) at Illinois Institute of Technology. Recently I was appointed Chairman of the Computer Science Department at Northeastern Illinois State College in Chicago." . . . A brief note from **Julian Cherubini** gives us the news that he is operating a medical instrumentation and hospital disposable marketing program for principals. He says he is looking for innovative products for patient care for evaluation and possible marketing.

OK, if you've read this far then it means that either you are mad about my prose or else that you enjoy learning about your classmates. Assuming for simplification that it is the latter, think how your classmates would enjoy some news about you. Please pick up a pen and paper *now* and drop a few lines to: **Frederick L. Morefield,** Secretary, Tiirasaarentie 17, Lauttasaari, Helsinki 20, Finland

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Robert Slott has been appointed director of Shell Chemical Company's Plastics and Resins Technical Center in Woodbury, N.J. Prior to this Bob served as director of Polymers Research and Development at Shell's Research Center in Emeryville, Calif. . . . **Paul Repetto** has been named vice president in charge of administration for the Chicago offices of Foote, Cone and Belding. In this post Paul will have responsibility for recruitment and assignment of account management personnel and training, development of internal communications programs and special projects in addition to general administration. At F.C.B., Paul has been account supervisor on the Kimberly-Clark account.

Lowell Krassner has been spending his weekdays at Unitrode in Watertown, Mass., and weekends leading trips for the Boston Chapter of the Sierra Club. This summer he is scheduled to lead a National Sierra Club week-long backpack in the White Mountains. Lowell has also worked on the preparation of snowmobile legislation and on other vital conservation concerns. . . . **William Rhoades** is employed at Hughes Aircraft in Fullerton, Calif., where he has been working on very high speed computer development programs.

Our mail contained a note from **Howard Graham** containing some notes on his activities: "After graduation and two years of military service, I spent eight years with I.B.M., the last three in Washington, D.C., as an industry development analyst in state and local government, data processing division. Things have transpired rapidly in the last two years. I met and married (at last!) the former Linda Lou Moye of Visalia, Calif., and Fresno State College. We now have a charming little girl, Mary Elizabeth. Meanwhile, leaving I.B.M., we moved to Asbury Theological Seminary in Wilmore, Ky., where I am half-way through the three-year program leading to a Master of Divinity degree. Feeling led into a teaching ministry, we anticipate that doctoral studies will follow our work here. All this seems quite a switch from chemical engineering and computer systems."

Another note arrived from Toni Schuman (the earthquake having prompted a rash of correspondence) telling us that she had met **Phil Friend** at a party in January. Phil left Control Data Corporation several years ago and helped found Intranet, a company involved in time-sharing on the 1108 and offering some interface hardware.—**Michael E. Brose,** Secretary, 199 Sudbury Road, Concord, Mass.; **Antonia D. Schuman,** 22400 Napa St., Canoga Park, Calif.

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Sorry for the lapse, I hope you missed me! However, without any news, it's hard to write a column. Things, fortunately, have picked up, so here goes.

I received a heartwarming note from **Dick Desper** who writes, "Scotty is the first of our five children to come to us by the adoption route. He originally came to us as a foster child, but we got used to having him around and applied for a legal adoption. Most of our fears about raising a black child have so far failed to materialize. We would like to put in a good word for our agency, the Boston Childrens Service Association, which, incidentally, is suggested by the United Fund. I am presently engaged in polymer research at the Army Materials and Mechanics Research Center in Watertown. In addition, my wife, Bea, and I have devoted a good deal of time to outside activities, such as the Needham school committee elections and the League of Women Voters.

Ken Taber dropped me a card to inform me that he is currently employed at G.E.'s Knolls Atomic Power Lab in Schenectady, N.Y., as a development metals joining engineer in the auxiliary operation (manufacturing engineering). He presently lives with his wife, Priscilla, and two daughters, Jill (5) and Jennifer (2) on the Great Scandaga Lake. He relates that upon arrival at G.E., he found **Marty Birnby** working in the structural metals joining operation. . . . **Steve Kaye** writes that he is partner and director of marketing, Cambridge Research and Development Group, Westport, Conn. The company's business is the development of patentable inventions. Steve lives in Westport with his wife, Rosalie, and three children, Bruce (7), Joan (5), and Peter (3) and is president of the Westport Congregation for Humanistic Judaism.

Pedro Rios has joined the General Electric R and D Center in Schenectady, N.Y. Sounds as if we should form a class of '59 Alumni Club at G.E. in Schenectady. . . . **Dave Weisberg** was recently appointed manager, Proprietary Products Division for U.R.S. Systems Corporation in San Mateo, Calif. . . . Also, out in the Bay Area, **Jim Brown** writes that he is senior member of the technical staff with Four-Phase Systems Inc. in Cupertino, Calif. . . . **George Cronin** is currently working at the U.S. Naval Ship Engineering Center, Hyattsville, Md.

Another Course III classmate, **Scott Latimer** writes that he is the Copper Department Superintendent at the El Paso Smelting Works of the American Smelting and Refining Co. (ASARCO). Hopes that everything is O.K. and says to give his regards to Glenn Zerdus and the rest

for him. . . . **Harold Smith** informs us that he is a propulsion engine scientist specialist with McDonnell Douglas Astronautics Co. in Santa Monica, Calif. He is living with his wife, Carolyn, and daughter, Audrey (16 mo.) in Fountain Valley, Calif. . . . **Fred Bielawa** has a new job as supervisor of cost engineering at Eastman Kodak's new film plant in Guadalajara, Mexico. He located there in November, 1970, with his wife, Patricia, and daughter, Nancy (17 months) and welcomes all old friends to visit when in Mexico. . . . **Seymour Rubenstein** writes that he is currently employed at North American Rockwell Information Systems Company (NARISCO) as Director of Management Information Systems. Family now includes three children: Marc (8), Marla (2), and Craig (11 months) and all enjoying California.

Malcolm O'Laughlin is now a senior consultant in the National Office of Management Consulting Department of Peat, Marwick and Mitchell in New York City. . . . **Ian I. Irons** informs us that he is a staff physician at Firelands Medical Clinic, Bellevue, Ohio, and also president, Medical Datamation Inc. a medical software systems company including automated medical histories. . . . **G. Neil Harper** is now president of CLM/Systems Inc., a fast-growing computer-based systems consulting firm in Kendall Square, with applications in finance, transportation, real estate development, and other civil systems areas.

Stanley Sharenson asked me to announce the birth of Andrew Harold Sharenson on October 15, 1970. He joins his sister, Meredith Faith, who is 3 years old. . . . **Michael Brunschwig** married in 1967 to Geegee Susman of Denver; Caryn Lynn born in 1969. Currently working as staff engineer for Martin-Marietta Corporation in charge of experiment scheduling for A.T.M. on the Skylab Program (solar telescope). . . . Captain **Bob Couch** presently working at the Air Force Flight Dynamics Laboratory—WPAFB, Ohio, as a staff scientist, is writing his dissertation for a Ph.D. in plasma physics through the Air Force Institute of Technology. Bob is married with four children.

Several press clippings received on **Joe Goodell** which respectively announced his appointment to the M.I.T. Educational Council and as District Chairman, Blue Trail District, Mattatuk Council of Boy Scouts. In addition to these positions, Joe, who is employed as manager of administration and control by Chase Brass and Copper Co. in Waterbury, is vice president of the M.I.T. Club of New Haven and a board member for the Newtown Montessori School. Joe lives in Southbury, Conn., with his wife, Margaret, and four daughters. . . . **Larry Broutman** was recently promoted to Professor at Illinois Institute of Technology in the Department of Metallurgical and Materials Engineering. . . . **Dick Hall** has recently published for the Air Force: "A Collection of Computer Programs for Molecular Spectroscopy." The 142-page document is described as "a series of computer programs useful in deriving molecular rotational constants and energy levels from observed rotational spectra of asymmetric rotor molecules." Available from the National Technical Information Service for $3.00 (or $.95 for microfilm copy)—A bargain at twice the price!

Jerry Schooler writes me from London, England, that he has recently been appointed corporate planning manager for G.K.N. Building Supplies and Services Ltd., a company which provides a wide range of products and services to the building and construction industries. Jerry is a member of the British Institute of Management and has found England a delightful place to work, "as intellectual as it is civilised." He extends an open invitation to all his friends and classmates to visit with him when they get to London.

An additional honor has come to one of our more illustrious classmates. **Walt Humann** was honored as one of the Ten Outstanding Young Men of America by the U.S. Jaycees. Joining Walt in this illustrious group are such familiar names as Elvis Presley, Ron Ziegler (press secretary to President Nixon) and Tom Atkins (first black elected to the Boston City Council). The announcement described Walt as "a former White House Fellow, who is one of the key men who recommended the establishment of the Postal Corporation, a reorganization which became law last August. He has conducted research on several of the major problems confronting the federal government. He is one of the youngest major corporation executives in the nation."

It is with regret that I pass on to you the news of the recent death of one of our classmates, **George F. Beardsley, Jr.** At the time of his death he was an Associate Professor of Physical Oceanography at Oregon State University, Corvallis, Ore. On behalf of the entire class, may I express our deepest sympathy to his wife, Barbara, his four children, his brother, Robert, who is on the staff at M.I.T., and his entire family. A memorial library and library fund in Physical Oceanography has been created in his memory at Oregon State University.

Well, that's about all for now. Please continue to keep me informed and I'll be talking to you next month.—**Arthur J. Collias,** Secretary, 61 Highland Road, Brookline, Mass.

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Edward Linde is with Boston Urban Associates which is now proposing to develop a 20-acre oceanfront luxury apartment complex in Swampscott, Mass. Linde was, along with his present partner Mortimer Zuckerman, formerly with Cabot Cabot and Forbes. . . . The December 19, 1970 issue of *New Yorker* magazine contained a major article about the elimination of cigarette advertising on

Walter J. Humann, '59.

radio and television, and **John Banzhaf**'s role in originally promoting required anti-smoking messages under the F.C.C. fairness doctrine. . . . **Jeremy E. Alperin** is now in ear, nose, and throat residency at Case-Western Reserve Medical School Hospital in Cleveland, Ohio. . . . **Hans K. Krog** received his master's of economics and business administration at Bergen, Norway. From 1964-1968 he was an engineer with an I.T.T. affiliate, S.T.K. A/S, in Oslo, Norway. Since 1968 he has been assistant director of Norwegian Industries Development Association, Oslo. He was married in 1965 to Evelyn Hix, and has two daughters, ages one and one-half and four.

Melvin B. Weiss has just completed two years with the U.S. Public Health Service and is presently a medical resident at New York Hospital and has one son. . . .**Richard Bronson,** M.D. is a resident surgeon at Bellevue Hospital, doing research in reproductive biology—ovulation and mammalian hybridization. **Richard P. Laeser** has a new position at the Jet Propulsion Laboratory as Deep Space Network ground systems manager for the Mariner Mars 1971 Project, which involves a Mars orbiter to be launched in May and inserted into orbit in November. . . . **Harold G. Snyder** plans to return to Cambridge to receive his master's and doctorate in the near future on the G. I. Bill.—**Gerald L. Katell,** Secretary, 122 North Maple Dr., Beverly Hills, Calif. 98005

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My thanks to **Mike Bertin** for accepting the challenge of doing some class notes. We will hear from Mike in a future issue. Mike reports all is well in the Bay Area and that he and Barbara have taken up skiing. . . . **Woody Bowman** is in the research department at the Chicago Federal Reserve simulating the money supply. We had a long talk on the phone recently when I was in Chicago. Woody reports that he is enjoying Chicago and that he gets along fine without a car. I just received my insurance bill and wish I could as well. Woody is single, which is encouraging as there are very few of us left. Another exception though is **Al Ramo** who is living near Philadelphia and pursuing work in geophysics.

Carol and **Pete Van Aken** are enjoying their new home in Winchester, Mass. Pete is in the president's office at B.U. and Carol is with D.S.R. at the Institute.

Caroline and **Ira Blumenthal** are living in Peabody, Mass., with their two children. Caroline called me recently and asked for advice on skiing which they are taking up. I hope, Caroline, that I was helpful. . . . Toby and **Bruce Eisenstein** report the birth of their first child.

Tom Gerrity and I were recently at an Entrepreneurship Seminar Committee meeting. Tom is chairman of the Boston session on law. He is part of the management and one of the founders of Index Systems. **Jim Champy** handles Index's legal problems and is also a founder. Jim lives three lives: Index, the construction firm and the M.I.T. Corporation. The latter is almost a full-time job itself. . . . **Larry Krakauer** is working with **Gary Stone**'s firm in Watertown, Mass.—that is, Gary was one of the founders.

I am with Computer Signal Processors Inc. in Burlington, Mass. Don Graham, '61, is one of the founders. We build very high speed computers for signal processing. The firm has less than thirty people and as a result is very interesting. Another of my jobs is chairing the National Seminar Coordinating Committee for the Alumni Association. I am leaving shortly for two weeks of skiing in Europe. —**Martin Schrage,** Secretary, 305 Mass. Ave., Arlington, Mass. 02174

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This month we have several Class Heroes. One of these is **Ed Casper,** who writes that an article he authored appeared in the January issue of the *Journal of Organic Chemistry*. The paper was part of his postdoctoral research at Yeshiva University. . . . **Paul Clermont** states that he is now managing a systems analysis group at Citicorp Systems, Inc. in Cambridge following four years with Peat, Marwick, Livingston and Co. He is married to the former Margaret Richardson (B.U. '65) and they have one son, born last October . . . **Jon Orloff** says that he is vice president of Dlektros, Inc., a manufacturer of scientific instruments. He and his wife Barbara-Lee raise rogs as a hobby.

Joe Parchesky became a Class Hero the hard way—by making a special trip to Memphis! I must admit, however, that the trip was not made especially for the Class of '64, but rather in connection with Joe's business as chief engineer for Datatype Corp., a Miami corporation manufacturing optical character reading equipment. Joe and his wife Carol have two children, ages 2½ and 1½.

And now for news of others: **Robert Blumberg** is working for J. H. Whitney and Co., a venture capital investment firm. He and his wife Joyce had a son born last November. . . . **Juan Crawford** is with Worldwide Development Corp., building equipment for the deep sea diving industry. Juan and his wife have four children, two of whom are twins.

Dayton Datlowe received his Ph.D. in physics from the University of Chicago last December and is now working in the physics department at the University of California, San Diego. . . . **Jeff Friedberg** is a geophysicist with Aero Service Corp. in Philadelphia. He and his wife Ann recently had their first child, a girl. Ann is the sister of **Jay Tenenbaum,** who has received his Ph.D. in E.E. from Stanford and is now working for Lockheed Missiles and Space Co. . . . **Wayne Matson** has become vice president and technical director of Environmental Sciences Associates, Inc. of Cambridge. Wayne received his Ph.D. from M.I.T.

James Doug McCallum is teaching in the Department of Town and Regional Planning at the University of Glasgow, while his wife Janice is editor of a journal in the field of Soviet Studies. . . . **Richard McEntire** is involved with an electron echo experiment sponsored by N.A.S.A. and will write his Ph.D. thesis on the data collected. . . . **Austin Purves** is teaching physics at Rivers Country Day School in Weston, Mass. He and his wife Marjorie have a two-year-old daughter

Larry Seligman is designing computers for Data General in Southboro, Mass. . . . **David Spencer** is manager of the Graphics Engineering Department of E.G.&G.'s Bedford Division. His wife Pamela gave birth to their first child last August. She is on the Curry College staff after receiving her Ph.D. in counciling psychology. . . . **Charles Wayne** spent last summer doing research at Princeton . . . **Hans Zapp** is working for the M.I.T. Lincoln Lab after receiving his Ph.D. from Stanford. He, his wife, and two children are living in Claremont, Calif., while he is on a field assignment. . . . That's the news—let me hear from you.—**Ron Gilman,** Secretary, 5209 Peg Lane, Memphis, Tenn.

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One interesting aspect of being class secretary is that you get letters from classmates you haven't heard from in a while. Most of them start out with "How did you get the job of class secretary?" **Jim Hester**'s letter continues with a report on his recent activities. After finishing his Ph.D. in city planning at M.I.T. in June, Jim spent three weeks at Minnesota Outward Bound School and three weeks driving around the midwest visiting friends. He is now working for New York City's Housing and Development Administration on policy analysis and urban information systems—and enjoying it. . . . **Art Bushkin** started his letter the same way and says that he is writing a book on future politics. Susan and **David Moran** are in Iowa City, Iowa where David is completing doctoral research on ship wave hydrodynamics at the University of Iowa. Susan is working for the university's Department of Special Education preparing curricula for handicapped children. The Morans have two children—a son, Scott, two years old, and a one-year-old daughter, Lindsay Elizabeth. Last year, Dave presented a paper "The Moral Response of Engineers to War Research" before the Iowa Academy of Science.

George Kossuth reports the birth in April (1970) of a son named Jonathan. George is still at the Draper Lab working on Apollo. Those of you who followed the flight of Apollo 14 may have seen him in some of the TV news films that were made at the Lab. . . . **Alan Schutz** has left the Draper Lab after four years to become director of engineering at Frequency Devices of Haverhill, Mass. The company manufactures instruments and pollution measuring equipment, and numbers several Draper Lab alumni among its management. . . . **Rob Silverstein** is now living in Potomac, Md., with his wife Ellen, son Seth, 2, and daughter Rachel, 1. Rob is still with T.R.W. and now manages the Strategic Systems Project Office at the T.R.W. Washington Operations. . . . **Robert Goeke** left Itek Corp. of Lexington, Mass. in November to join the M.I.T. Center for Space Research. Robert and his wife Ann live in Arlington, Mass. . . . **John Krause** reports the birth of a daughter, Miranda, on November 5, 1970. John is a Senior R and D Engineer in the Acoustics Research Section of Electric Boat Division of General Dynamics.

Wayne Haase reports a return to a lower form of life as he is now working toward a Ph.D. at the Stanford Integrated Circuit Laboratory. . . . **Leo Rotenberg** is expecting to complete his Ph.D. in computer science at M.I.T. in June. His thesis is about privacy and security in a computer utility. . . . **Robert Bobrow** was married last June to the former Lynette Levy who had been doing research for his thesis advisor. Robert and Lynette spent three weeks driving cross country to the University of California at Irvine where Robert is now Acting Assistant Professor of Computer Science. He expects to complete his Ph.D. at M.I.T. in September and to remain at Irvine. Robert reports that teaching is fun but a lot of work, and that he loves California.

Class Agent **Jim Wolf** has sent me a note concerning our class' contributions to the Alumni Fund. Last year we failed to achieve our goal of 50 per cent participation and this year we are behind last year's progress. With the current financial situation what it is, the Institute needs our help, and I would like to join with Jim in encouraging all our classmates to participate in the Alumni Fund. I hope readers of this column will spread that word to other classmates. In the same vein, the column depends on the notes you send, mainly on the notes on Alumni Fund envelopes. At this point we have only a small reserve of news and can project a small May column and none at all in June. So please write.—**Steve**

Lipner, Secretary, 940 Belmont St., Watertown, Mass. 02172

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The mailbag is a bit skimpy this month so we'll just take it from the top of the pile. **Nick Negroponte,** an assistant professor of architecture at M.I.T., co-authored an article in the October issue of *Architectural Forum.* Apparently the article is based on his book *The Architecture Machine,* published in 1970 by M.I.T. Press. . . . **Gordon Olson** reports there is a lot of snow in Buffalo, N.Y.

Forrest Stoddard is a lieutenant in the U.S. Air Force, assigned to the V/STOL Division of the Air Force Flight Dynamics Lab at Wright-Patterson Air Force Base, Ohio. Upon completion of his military obligation, he plans to go into ocean engineering. Since being in the air force, he says he has bumped into many classmates and professors from M.I.T. . . . **Pete Addis** is doing volunteer work with the mini-computer at the Neurophysiological Research Lab at McLean Hospital, Belmont, Mass., as well as taking graduate computer courses at Boston University. . . . A letter from **Terry May** reveals he is a first lieutenant in the Army and has been stationed in Nha Trang, Vietnam, since June, 1970. For the first six months there he ran the three Officers' Clubs in the area. After that he was assigned to the intelligence section of II Corps Artillery Headquarters. In March he plans to return to the academic life at U.C.L.A. Graduate School of Business.

On Christmas Day, 1970, **John Adger** married Carolyn Louise Temple in Hammond, Ind., where her father is a Methodist minister. They have returned to Tripoli, Libya, where she is teaching English in a school for dependents of oil company personnel, and he is working as a junior geologist/geophysicist with Mobil Oil Libya, Ltd. Anyone passing through their area is asked to look them up. . . . Elaine and **David Vanderscoff** and their three-year-old daughter Jessica are enjoying living in suburban Dix Hills. Life continues as usual with Dave commuting daily on the infamous Long Island Railroad from Dix Hills to Manhattan, where he still works at New York Life Insurance and is taking actuarial exams. He has passed Part 7, leaving only three more to go before obtaining Fellowship in the Society of Actuaries.

That's all for this month. Looking forward to seeing you all again at the reunion in June. Cheers!—**Terry J. Vander Werff,** 2049 Manchester Drive, Fort Collins, Colo. 80521

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Don Berliner recently wrote to let all his friends know what he's doing. He left University of Pennsylvania and is now hawking his wares, and his wife Diane of a few months is doing the same. They are temporarily residing in N.Y.C. while checking the prospects. In their spare time Don and Diane have been dabbling in lucite sculpture. Don is also continuing his jazz piano work and has taken up the study of serious comedy under the tutelage of Mr. Steve Allen. . . . **Robert Shishko** is living in sunny Southern California in a dual role as a graduate student completing his Ph.D. dissertation for Yale and as an economist for Rand Corporation in Santa Monica. . . . **Harry Pellow** is with General Electric in California designing mixed oxide, fast flux, sodium cooled breeder reactors. . . . **Lutz Henckels** hopes to get his Ph.D. in electrical engineering in June from M.I.T. . . . **Mark Fineman** is still working on a Ph.D. in systems and information science at Syracuse University. In order to make ends meet he has implemented an on-line student record retrieval system. . . . **Ed Radlo** is in his second year at Harvard Law School; he has been working on legislation which attempts to extend constitutional rights to juveniles of Massachusetts. . . . Having taught physics for two years in the Peace Corps in Ghana, **Richard Gauthier** is finishing a master's in physics. He is also involved in a new course in physics for liberal arts majors at Illinois. He is planning to enter a Ph.D. program in neurological psychology. . . . **Robert Trunek** is a project engineer for Atlantic Richfield in Houston; he is also working on an M.B.A. at University of Houston.

Gerald Udinsky is now working on a Ph.D. in economics at Berkeley, after having suffered through four years of physics at Tech. He writes: "I hope that other TECHnical men will have the opportunity of leaving an engineering oriented social environment and experiencing the joys of culture: art, music, literature, drama . . . in a setting conducive to such endeavors. How wonderful it was for me to discover that man is emotional as well as rational, that he can feel as well as think, and that he can hear, see, feel, and taste. There is a large and wonderful world beyond the grey, fluorescent-lighted, enclosed hallways of M.I.T.". . . . **John Ritsko** will be in Vietnam until September when he will return to Princeton to complete his Ph.D. in physics. He is serving with the 20th Engineering Batallion, and the army claims to be using his physics knowledge by having him run an asphalt plant. . . . On February 14, 1970, **Barry Watkins** married Martha Armstrong. He is employed by Budget Bureau of the city of Rochester. . . . **Charles Spann** is out of the army and has returned to West Virginia University to complete his master's in air pollution control engineering. . . . After graduation **Stanley Wu-Wei Liu** worked for a year at the Cambridge Electron Accelerator Lab of Harvard and M.I.T. while he was a special student at Harvard. Since September, 1968, he has been at University of Pennsylvania, obtaining his master's in 1970 and working towards a Ph.D. in solid state physics. On August 15, 1970, he married the former Judy Chinn-Hwa Lin, and they have been living happily ever since. . . . **George Nybakken** is doing doctoral work at University of Michigan. . . . **Margaret Jones** received an M.B.A. from Harvard in 1970 and went to Europe. She returned in August and began work in marketing with Colgate-Palmolive in N.Y.C. While in Europe she visited **Eileen Tate Cella** in Pisa, Italy, and **Martha Redden Kimball** in Cambridge, England. Martha was married last year and is studying at University of Cambridge. . . . **Douglas McCraith** is working with Lincoln Lab Group on Ambulatory Care Service.

Jack Farber has taken a leave of absence from Columbia. He was dissatisfied, at least temporarily, with the prospects in a theoretical physics career. Things are more relevant now, but less solvent, as he has been unemployed for a year. . . . **David Saunders** married Judy Anderson (University of Michigan, '68) May 23, 1970, in Ludington, Mich. **Isom Herron** was best man, and John Sheats, '65, was an usher. James Butler, '66, was also present. . . . **Hisayuki Handa** has returned to M.I.T. for a doctorate in mechanical engineering. He will probably work in the Gas Turbine Laboratory. . . . **Mark Grossman** is still with R.C.A. in Princeton, N.J. He is also attending Stevens Tech in Hoboken to work towards a Ph.D. in operations research.

Up until the demise of his company, **Alan Gevins** was a senior systems programmer specializing in real-time biomedical applications. Now he is writing his doctoral thesis "Consciousness and the Nervous System" at the California Institute of Asian Studies. . . . **John Gowdy** received a Ph.D. in electrical engineering from University of Missouri and Columbia in January. . . . **James Gips** completed two years service at N.I.H., travelled around the world, and is now back at Stanford doing work in computer science. . . . **Kenneth Barbour** has left the army and has returned to M.I.T. to complete an S.M. He says that the army has been a waste of time. . . . Louise and **Stanley Rose** have purchased a home in Reading, Mass. They love the clean air, but they have nothing good to say about shoveling snow.—**Jim Swanson,** 774 Channing, Palo Alto, Calif. 94301

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The Charles River is now beginning to thaw out a little as I write this, although I doubt if it will last. Boston has just completed a period in which the lowest daily temperature was below freezing for 72 days in a row, breaking the previous record of 62 consecutive days. The Cambridge Gas Company across the street from us has an extremely noisy process they use to supplement their natural gas with a mixture of propane and air in order to meet peak demand. It is only used when the *average* daily temperature reaches 13° F, and was used only twice in the past two years. This year they had to use it at least six times

to meet heating demands. But I must say in all fairness to them that helped restore my faith in the free enterprise system when they agreed to steps to sound-proof their process. Boston is not the coldest place in which classmates have to live. I recently received an address change from **John DeManche.** He's now living in Anchorage, Alaska!

Coed Baby Contest (cont.)
As you may recall, in the December issue we announced the birth of Theressa Silver who we thought was the first baby born to a coed in the class. The February issue corrected this and gave the honor to Michael Brothers, a good friend of Theressa. This month's mail brings news of a new junior member of the club, Michael McCandless, the ten-month-old son of Bill ('70) and **Stephanie (Seneff) McCandless.** Stepanie writes that Michael's favorite occupation "is tearing up and eating computer paper" which is plentiful since she and Bill are "all wrapped up in computers." He is working for Teradyne, Inc. studying MOS testers and she works part-time for Lincoln Lab on speech analysis and synthesis. Being suburbanites, their favorite hobby seems to be remodelling and repairing their house in North Reading which they bought last year. . . . Elaine Leemon ('70) and **Dan Gruber** were married in July 1970 and are living in Edison, N.J. Elaine writes that she has been looking for work in the computer field but has found the job market very tight, especially for an inexperienced person. . . . Finally Vivian and **John Moffatt** are the proud parents of Genevieve Ruth, born on November 22, 1970. John has returned to work at Service Technology Corp. (L.T.V.) on contract to the Department of Transportation in Cambridge as an analyst. He still consults in his spare time for Solar-Environmental Sciences, Inc. and Applied Geodata Systems Inc.

Military Miscellania
Lieutenant **John McFarren** is stationed at Mountain Home AFB, Idaho as an RF-4C navigator with the 22nd Tac Recon Sq. . . . Lieutenant (J. G.) **Jack Rector** is flying P-3 aircraft in Patrol Squadron 10 Antisubmarine Warfare at Brunswick NAS, Maine. His wife Bonnie completed her B.S. in home economics from U.N.H. in January and they are living in Salem, N.H. with their daughter Kimberly (22 months). . . . Lieutenant (J. G.) **Paul Miller** is in the ground part of the navy. He is training with Seabee Team 4005 to deploy to Truk Island in the Pacific to do Civic Action for eight months. But don't feel sorry for him, he just finished six months in the Bahamas (!) with a Seabee detachment.

George Phillies recently joined the Army Reserve in the 338th Medical Detachment (Dental Service). He has retired as president of the M.I.T. Science Fiction Society after three years of distinguished service and is now serving in the Ashdown House Executive Committee and the Graduate Student Council. George is now finishing his S.M. and plans to stay at the 'tute for a doctorate. Americans are not the only ones in the world blessed with the prospect of military service. **Vahe Davidkhanian** has been back in Tehran for about a year and has been serving in the Iranian Army for about five months. Vahe says that there is an active M.I.T.-Harvard alumni club in Tehran which meets monthly. He also reports that **F. Abtahi** has also returned home.

Somewhat closer to home, **Jack Cleary** writes that he is teaching math in Waltham after receiving an M. Phil. in economics from Yale last June. "Being an eternal student," he plans to go to law school next year, although he doesn't know whether it will be the East Coast or California. . . . **Nathan Curland** is working for Micro-Bit Corp. in Lexington.

As this is being written, Dr. Killian is about to present to the M.I.T. Corporation a proposal to allow for the direct election of younger alumni to the Corporation. Dr. Killian deserves direct credit for this move which I believe shows M.I.T.'s interest in keeping up with the times. It appears that many, perhaps all, members of the class will be eligible to vote and run for election this year. I strongly urge everyone to participate in this election procedure by nominating yourself, if interested, or others you know, and by voting. (This is not a personal plug since Gail and I are probably ineligible for election because we will still be M.I.T. students.) A large voting turnout will show that we really care.—**Gail and Mike Marcus,** Secretaries, Eastgate Apt. 16A, 60 Wadsworth St., Cambridge, Mass. 02142

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I have received a letter from **Tony Lin** who was my first roommate at the Institute. We shared a room in Senior House during Rush Week before Tony moved on to Burton House. Since graduating Tony has made a hitchhiking trip around the U.S. and Canada before joining the Peace Corps. He is currently posted as a teacher in a Chinese high school in an isolated timber town in Sabah, Malaysia (formerly North Borneo just across the border from Indonesia). His duties include teaching physics, chemistry, and English while managing the school's laboratory. Tony considers his work as a Peace Corps volunteer to be a "worthwhile experience" and has improved his Mandarin considerably and has learned to read and write Chinese. Harvard Business School will be his next task when he returns to the U.S. in September. Until then, Tony would like to hear from anyone about "how things are going at the Institute and in the states." News magazines arrive about two weeks late, and Tony feels rather isolated from the world's events. His address is P.O. Box 295, Tawau, Sabah, Malaysia.

The following are busy continuing their education. . . . **James P. Kornberg** is pursuing his Sc.D. at Harvard University in the Department of Environmental Health Sciences (School of Public Health) in the area of air pollution control. . . . **Joel S. Davis** is studying astro-geophysics at the University of Colorado. . . . **Alan M. Goldberg** is currently enrolled in the Ph.D. program at the University of Texas in astronomy. . . . **Sharon Grundfest** is in her second year at Columbia University studying medicine. . . . **Edward M. Waibel** received his S.B. and S.M. in mechanical engineering from the Institute in June 1970. He is now working toward his M.B.A. at Harvard University. . . . **Alvin Fort** is enrolled in his second year of medical school at New York University.

Wedding bells have rung for the following classmates. . . . **Eugene F. Mallove** married the former Joanne K. Smith from Wellesley Hills, Mass., in September 1970. They are presently living in Waltham, Mass., while Eugene is working for Hughes Research Laboratories (Malibu, Calif.) as a consultant in absentia. . . . **Robert Ccle** has married the former Diana Cole of Andover, Mass., and has moved to Los Angeles to work for the data systems division of Litton Industries. He will receive an M.S. degree from U.S.C. in computer science this June. . . . **William L. Roberts** has been married for a year to the former Miss Tonia Nobell. Tonia was a special graduate student at M.I.T. in 1965-66. She nows runs her own graphic design firm in Boston known as Graphic Communications. Bill is working as a city planner for the City of Boston Public Facilities Department, planning schools and other facilities for the city.

Charles J. Schwing and his wife Ann are teaching in North Attleboro, Mass. Charles reports that after several skirmishes with his Selective Service Board he has managed to retain his 2-A classification. . . . **Paul Beckerman** is working in the Valle Alto de Cochabamba in Bolivia, with credit cooperatives and two irrigation projects, as a Peace Corps volunteer. . . . **Roy Gene Autry** is presently employed as an electronics engineer at the Air Force Weapons Lab while attending the University of New Mexico as a graduate student in physics. Roy hopes to do graduate work in astronomy at the University of Pennsylvania or the University of Florida next year. . . . **Richard A. Pinnock** entered active duty as a second lieutenant in the Army's Signal Corps on October 14, 1970. Richard finished his Signal Officer Basic Course at Fort Gordon, Ga., on December 17, 1970. He will finish his Radio Systems Officer Course at Fort Monmouth, N.J., on May 19, 1971, and will be assigned to West Germany thereafter. . . . **George Claflen** worked for Professor Jack Myer's office of Ashley, Myer, and Smith in Cambridge after graduation. He is now working for Professor Chet Sprague on a community high school at Rough Rock on the Navajo Indian Reservation. George has also taught for two years at the Boston Architectural Center. . . . That's all for this month.—**Richard J. Moen,** Secretary-Treasurer, 412 Hastings Hall, Cambridge, Mass. 02138

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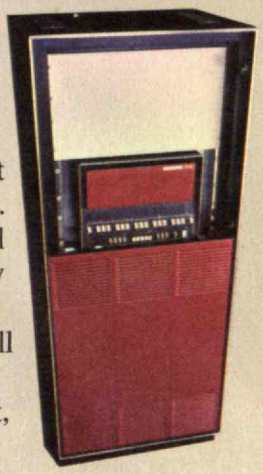

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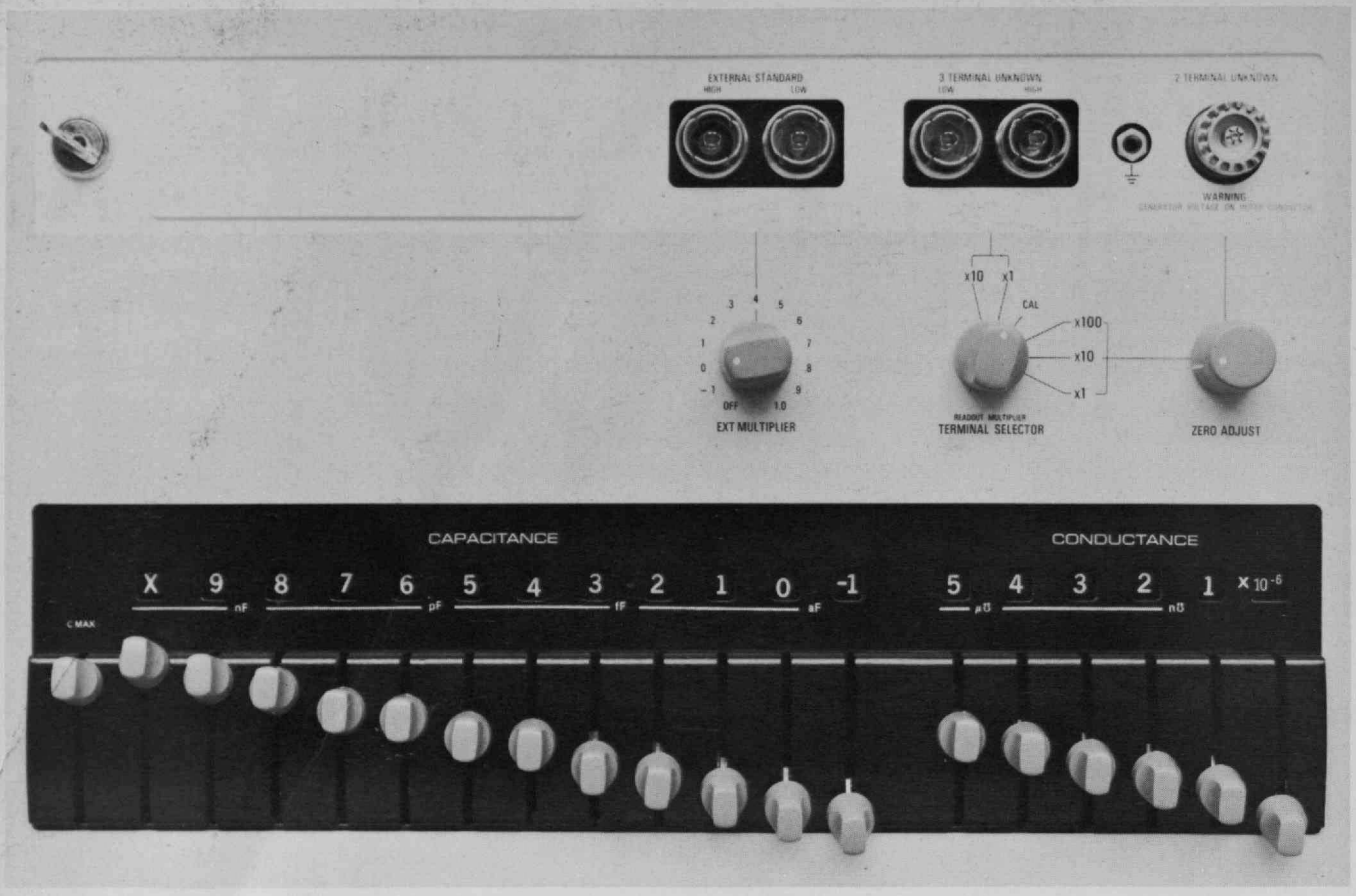

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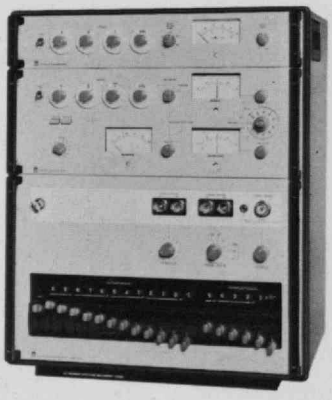

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